A Scranton Gillette Publication

JULY 1961

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

UNIVERSITY MICROFILMS
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COMP

Water Treatment Plant at Vinas Cue, Asuncion, Paraguay . . . (p. 283)

Regular Submersible

SUBMERSIBLE PUMPS

deliver water

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consistently

silently

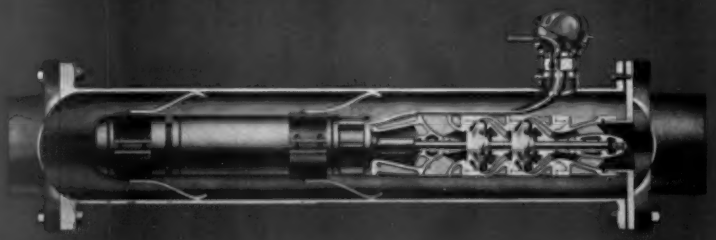
efficiently

The Layne Submersible Pump installation gives you noise free operation because the pump and motor are completely submerged. The Layne Submersible is adaptable to all wells; requires a minimum of space since no pump house is required; eliminates possibility of water contamination; and eliminates the opportunity for vandalism or other accidental mishap or damage.

Layne Submersible Pumps are available for wells as small as 6 inches and in capacities from 30 GPM up. For additional information write for free bulletin number 202.

The Layne In-Line Submersible pump provides the answer to many problems in booster pump applications. The pump operates as an integral part of the line and is designed for use by municipalities, industry, such as petroleum and chemical plants and by agriculture. Advantages include: simple installation, no additional space required, continuous service even under flood conditions, and no possibility of surface water contamination.

Layne In-Line pumps are made as small as 4 inch bowls on a 4 inch motor for use in a 6 inch pipe to deliver 30 GPM. Larger sizes are available as required. For additional information write for free bulletin number 203.



In-Line Submersible

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LAYNE & BOWLER, INC., MEMPHIS

General Offices and Factory, Memphis 8, Tenn.

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Easy-Read has the biggest, most readable face yet to appear on the market. Its permanent digits stand a full ¼" tall. A special heavy tempered glass lens protects Easy-Read's face and preserves the seal. The tempered glass is highly resistant to breakage and scratching.

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Ask your Badger representative for full details and an Easy-Read demonstration.

The new Easy-Read can be ordered in split-case (⅝" thru 2") or frostproof models (⅜" thru 1" x 1¼")

Badger Meter Mfg. Company

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air capital of the world, specifies P.F.T.

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Underlying central Kansas are 1,000 square miles of water-saturated gravel beds, known as Equus Beds. This tremendous water source, forming, in effect, a subterranean lake, provides Wichita with 70 million gallons of water per day. As a part of its important pollution control program, this progressive city selected the following P.F.T. equipment.

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P.F.T. is proud to share in the continued growth and development of Kansas' largest city—Wichita.

The Wichita Sewage Treatment Plant Designed by Black & Veatch, Consulting Engineers, Kansas City, Missouri.

P.F.T.

waste treatment equipment exclusively since 1893

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WATER & SEWAGE WORKS

VOL. 108 NO. 7

JULY 1961

A Scranton Gillette Publication

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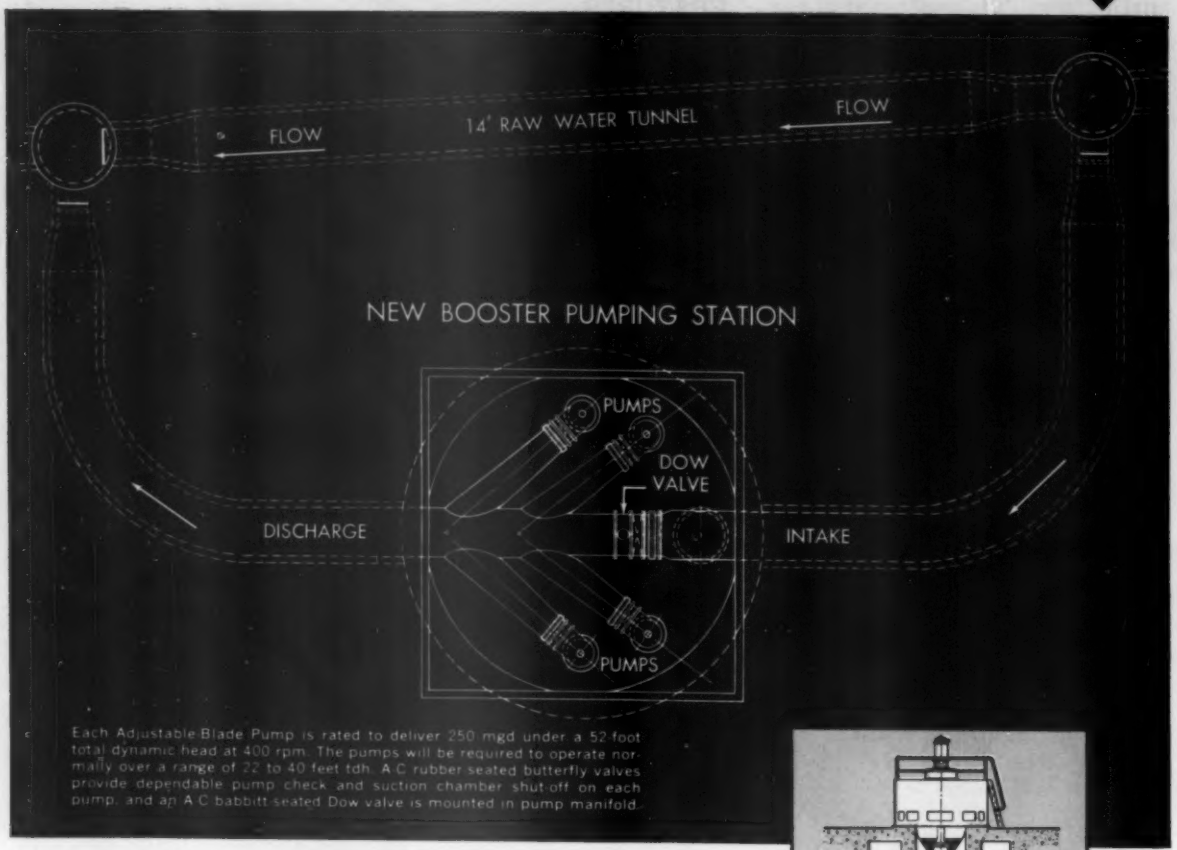
ALLIS-CHALMERS



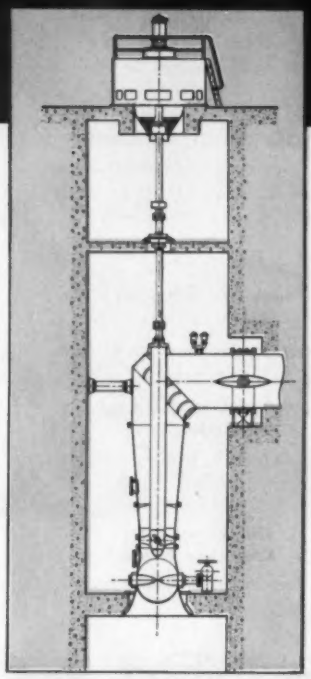
Each Adjustable-Blade Pump is rated to deliver 250 mgd under a 52 foot total dynamic head at 400 rpm. The pumps will be required to operate normally over a range of 22 to 40 feet tdh. A-C rubber seated butterfly valves provide dependable pump check and suction chamber shut-off on each pump, and an A-C babbitt seated Dow valve is mounted in pump manifold.

A-C Adjustable-Blade Pumps help City of Detroit augment raw water supply!

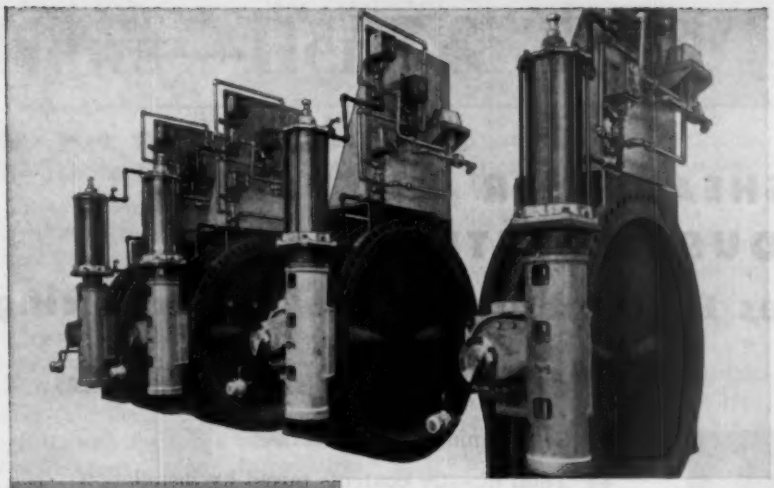
To augment the supply of raw water, Detroit, Michigan has installed four A-C Adjustable-Blade Pumps in a new booster pumping plant near the Detroit River. Pumps of this type were selected for their rapid, smooth response, under automatic control, to a wide range of flow demands.

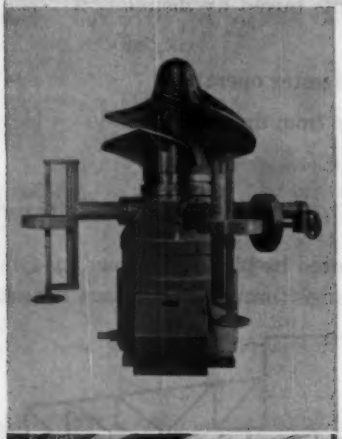
Adjustable-Blade Pumps will vary in output to meet the gradual changes in flow requirement as compared to stepped increments of flow and possible surges which would result if fixed-blade pumps had been installed.

Two of these pumps will operate when required to raise the hydraulic grade line and supply adequate raw water to two remotely located treatment stations. As demand increases, a third pump will be used. A fourth pump is available for standby service. Pump blade angles are controlled automatically by a positioner responsive to downstream hydraulic grade line. A-1488



You may obtain full information on A-C Adjustable and Fixed-Blade High Capacity Axial Flow Pumps and Valves by writing to Allis-Chalmers, Hydraulic Division, York, Pennsylvania.

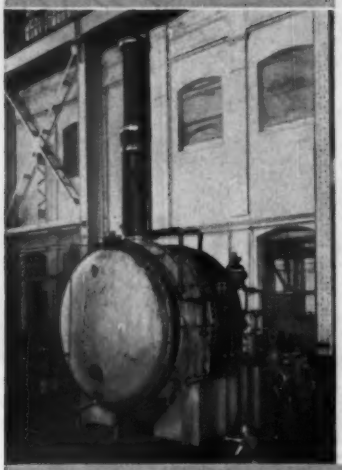




Four Allis-Chalmers 90-inch 50-16 fabricated steel butterfly valves used for pump check. These valves are equipped with the A-C full body rubber seat for dependable bubble-tight shut-off. Hydraulic cylinders, mounted on rugged crosshead mechanisms, provide smooth automatic operation.

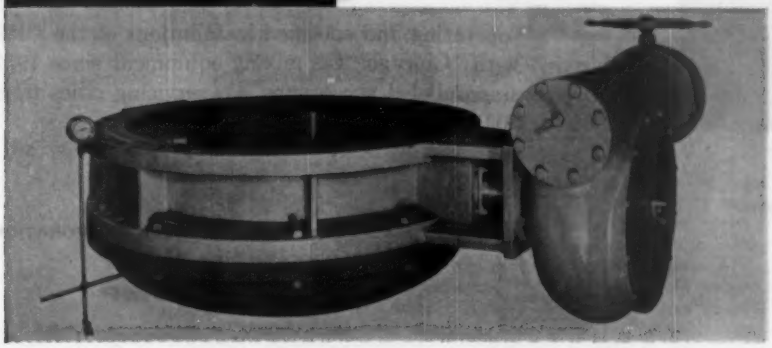
A-C adjustable-blade pump impellers are dynamically balanced after complete shop assembly and blade finishing.

ALLIS-CHALMERS



Allis-Chalmers 144-inch Dow valve with fabricated steel body and hydraulic operator provides tight closure in both directions. When valve is open, flow bypasses pumps or is diverted to pump sumps when valve is closed.

One of four A-C 72-inch AWWA Class 50-16 fabricated steel butterfly valves used on pump suction. These valves are equipped with the A-C full body rubber seat and A-C manual operator. This valve is shown being tested with 50 psi air under water to insure bubble-tight shut-off.



Maine Water Utilities Association Meets

The Maine Water Utilities Association met in April at Bowdoinham, Me.

The subjects at hand concerned one of the state's newest water systems located in Bowdoinham, a discussion of steel standpipe painting procedures and experiences.

A paper was presented discussing "Epoxies, a New Era in Coatings Industry" with emphasis on coatings for steel standpipes and reservoirs.

Contract Awarded for World's Largest Prestressed-Concrete Reservoir

The Preload Co., Inc., New York, N. Y., has been awarded the contract to prestress the world's largest prestressed-concrete reservoir.

The 28-million gallon reservoir will have nearly twice the capacity of the present largest prestressed reservoir and is to be constructed at Alderwood Manor, Snohomish County, Washington. It will be 370 ft in diameter with 27 ft-6 in. high walls. It will have a "dished" bottom which will hold about 25 percent of the tank's capacity. The reservoir will be unroofed and will cost nearly $600,000.

Preload will prestress the tank by wrapping it with multiple layers of wire. The wire will be applied while under tension and will impart an inward force which will counteract the outward force exerted by the tank's contents when in service. The wire will be wrapped by a self-propelled machine which will be suspended along the outer surface of the tank from a carriage that will ride along the top of the wall.

Prestressing enables a much thinner concrete wall and results in lower construction costs.

Russmussen & B-E-C-K, Seattle, Washington are the general contractors.

Consulting engineers are Gray & Osborne, Seattle & Yakima, Washington. Alderwood Water District Commissioners are: C. P. Ballard, Chairman; James Davis, Secretary; Nile A. Patterson, Commissioner. Mike Lindbloom is Water District Superintendent and Les Erikson is Water District Engineer.

"from Chicago"

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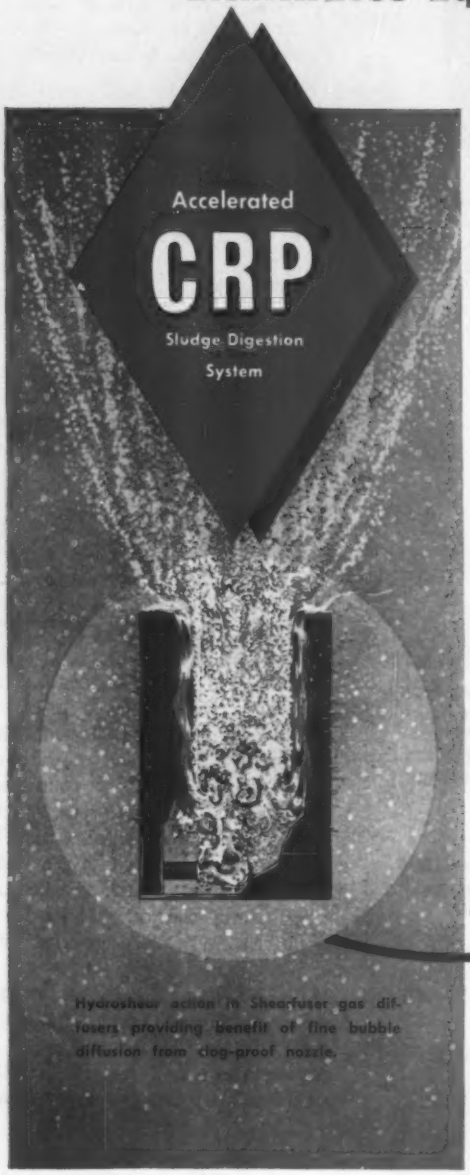
Eliminates Equipment Removal for Servicing



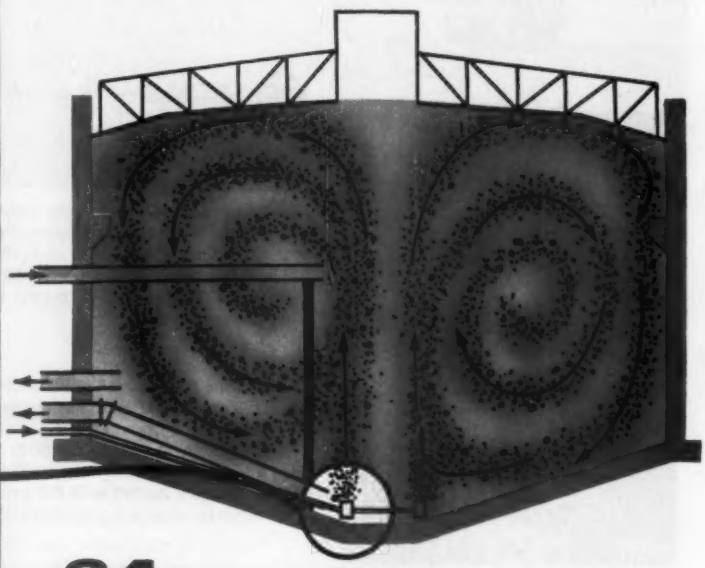
Hydroshear action in Shearfuser gas diffusers providing benefit of fine bubble diffusion from clog-proof nozzle.

EXCLUSIVE BENEFITS OF SHEARFUSER DIFFUSERS

1. Self-cleaning during gas flow.
2. Total digester contents mixed by installation on tank bottom.
3. No interruption of digester operation.
4. Increased mixing rate from fine bubbles induced by Hydroshear action.

*CRP Accelerated Sludge Digestion System**

Reduces tank volume required by high sludge loading rate. Produces homogeneous sludge through continuous mixing.



64 operating and specified installations of the CRP System* with "Chicago" gas mixing equipment since 1952 prove its unparalleled acceptance . . . servicing cities from 2000 to 250,000 population.

***System license under U. S. Patent No. 2777815 and foreign patents available.**

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News—Here & There

New York Engineer Leaves for Job in Saigon, Viet Nam

Seymour Zubkoff, who recently resigned from the DeLong Corp., New York City, is now principal engineer on the staff of the Hydrotechnic Corp., consulting water resources, hydraulic and sanitary engineers of New York City. Mr. Zubkoff is currently assigned to Hydrotechnic's office in Saigon, Viet Nam, in connection with the firm's work for the new Saigon-Cholon Metropolitan Water Supply project for the Government of Viet Nam.

Prestressed Concrete Article Available

A reprint of "The Prestressed Concrete Products Industry" by Sidney Gertler, which appeared in the June issue of Construction Review, has been made available. The article should be of particular interest to engineers interested in structural design. It is the first definitive survey of the Prestressed Concrete Industry and brings into focus the dynamic growth of this industry in the United States during the last decade. The article contains specific tables and charts evaluating the potential of the field and the uses of Prestressed Concrete in the 1950's. The reprint is available through Mr. Charles P. Redick, director, Building Materials Division, U. S. Department of Commerce, Business and Defense Services Administration, Washington 25, D. C.

CORRECTION

The fine article, "Installing a Sewage Lagoon and Lift Stations," by Mr. Donald L. Floan, which appeared in the May issue, mistakenly gave Mr. Floan's address as Minneapolis, Minn. We wish to acknowledge Mr. Floan's address as East Grand Forks, Minn.

Photometer Only Measuring Device for Turbidity

Two specialists, W. R. Conley and R. W. Pitman, authors of "Innovations in Water Clarification," which appeared in the October issue of The Journal of American Water Works Association, have stated that the only instrument that has the necessary characteristics for adequate measurement of filtered-water turbidity for filter plant control purposes is a modified light-scattering microphotometer manufactured by The American Instrument Co. (Aminco) of Silver Spring, Md.

"The instrument can detect substantial amounts of turbidity in the best grades of distilled water," they said. "Such sensitivity is of extreme importance in the rapid evaluation of filter media and the coagulation process because very small difference in filtered water turbidity can be used to establish a basic understanding of

CONTINUED ON PAGE 10A

Reader Response

Letter from C. E. Keefer

Sir—Algae Growth Rate in May 1961 Water and Sewage Works Table 2 should probably relate to tests where there was an *adequate* CO_2 supply.

C. E. Keefer
Baltimore, Maryland

Correct, Sir, and thank you.—Ed.

Pages Punched and Perforated

Sir—In response to Mr. Richard Carpino's letter, published in the June 1961 issue of W & S W, I will offer the following suggestions:

First: With regard to perforations, the lightweight paper used in printing the magazine would not stand repeated notebook use without reinforcement.

Second: It will require arranging the articles within the magazine so that the end of one article and the beginning of the next article do not appear on opposite sides of the same page.

Robert E. Vansant
Black & Veatch
Kansas City, Missouri

These are indeed problems. Mr. Vansant also notes that he "unbinds" the magazine and files the articles loose in conventional file folders.—Ed.

Sir—The suggestion made by Mr. Carpino for tear-out punched pages is an excellent idea as you have noted. If the step were taken it would simplify filing problems and allow the individual to "build" his own handbook for a particular area of interest.

James J. Anderson
Assistant Engineer
Minneapolis-St. Paul Sanitary Dist.
St. Paul, Minnesota

Sir—ON THE NATIONAL SCENE in the June issue carried a report that Mr. Frank J. Welch, Assistant Secretary of Agriculture, predicted that 15 times more water will be demanded in 2000 than in 1954 in eastern U.S. He proposed that saline water conversion and induced rainfall be looked into as ways to meet the problem.

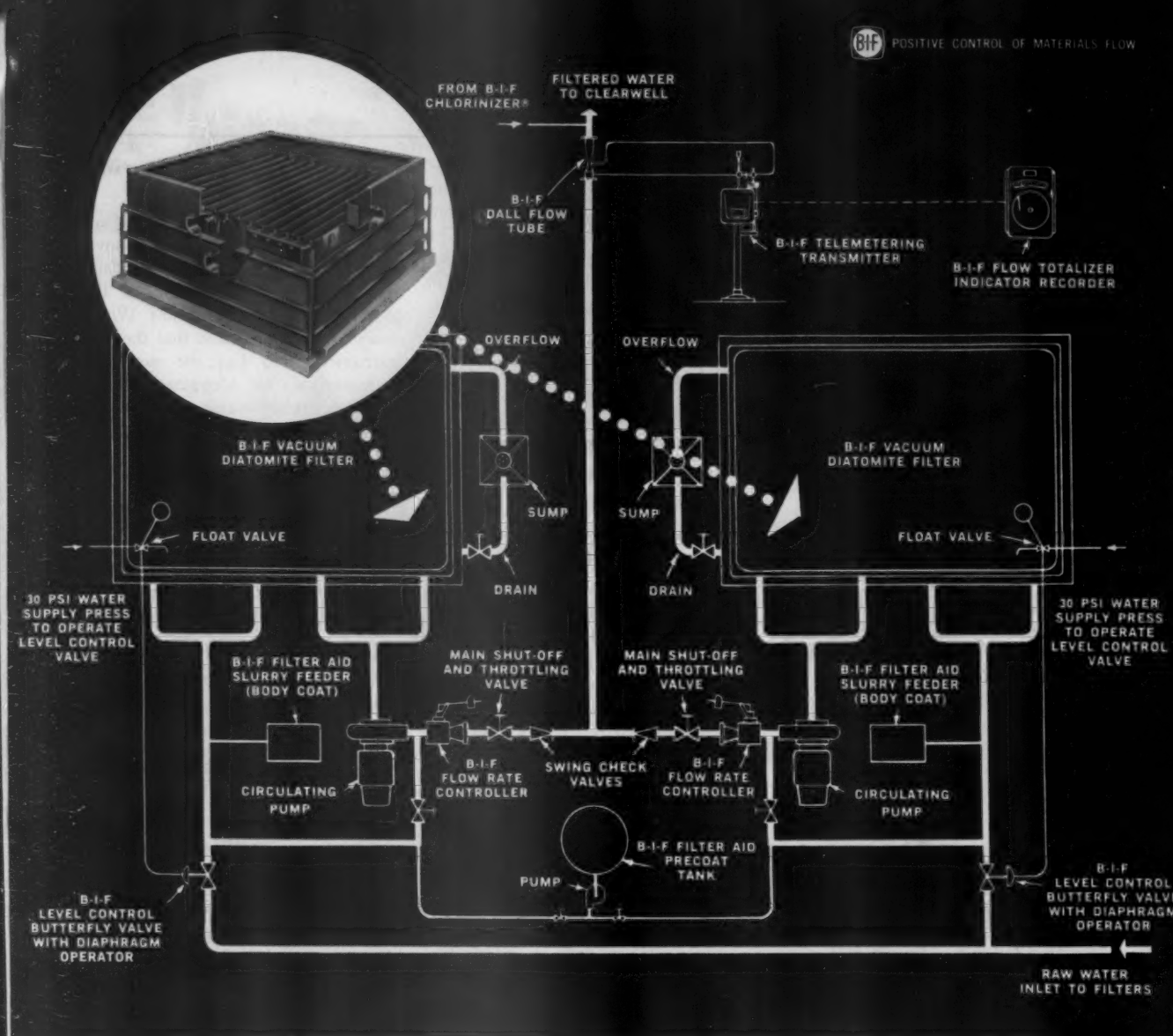
This prediction is at variance with the findings of the Kerr Committee, which estimated a 5-fold increase in water withdrawal in this area by 2000, of which 17% would represent consumptive uses. Also, the depletion from water use would amount to only 11% of the low flow from runoff. Thus there does not seem to be much cause for alarm in this relatively water-rich region.

Saline water conversion has caught the public fancy as a panacea for water shortages everywhere. The cost of water conversion will undoubtedly decline with improvements in technology, but it is never likely to be competitive with direct use of surface water even where elaborate treatment of raw water is necessary. Saline water conversion will find its proper place in the economy but it will not be a substitute for maximal use of fresh water; conservation and reuse of water comprise much cheaper methods for augmenting natural supplies.

Richard D. Hoak
Senior Fellow
Mellon Institute
Pittsburgh, Pennsylvania

Dr. Hoak is correct. W &S W miscalculated Mr. Welch's prediction, which was based on the Senate Select Committee's findings that five times the 1954 *withdrawal in the east would be required in* 2000.—*Ed.*

Water and Sewage Works likes to hear from its readers. Reader Response will continue to air readers' beliefs, but keep them short and current, please. Send your response to Editor, Water and Sewage Works, P.O. Box 1315, *Lansing Michigan.*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PUMP
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B-I-F LEVEL CONTROL BUTTERFLY VALVE WITH DIAPHRAGM OPERATOR
RAW WATER INLET TO FILTERS

New **B-I-F** *low cost filtration system meets peak load demands!*

You no longer need high cost expansion to meet peak load demands. At a fraction of the cost formerly required, B-I-F can provide a completely integrated filtration and treatment system. The low installation, operational and maintenance costs save thousands of taxpayers' dollars.

This B-I-F system is built around low cost, performance proven Vacuum Diatomite Filters. The filters' open tank design permits simple visual operation . . . and easier inspection and accessibility. Fiberglass construction eliminates annual painting and repair of protective linings. Chemical pre-treatment is simplified. Wash water requirements are minimized.

From its line of compatible components . . . filters, chemical feeders, instrumentation, butterfly valves, etc. . . . B-I-F will provide a coordinated system to meet your specific peak load requirement. A B-I-F system requires minimum start-up time . . . assures maximum reliability, flexibility for further expansion, and dependable, single responsibility.

Write for the facts! B-I-F Industries, Inc., 350 Harris Ave., Providence 1, Rhode Island.

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Here are a few advantages of TARSET over other coatings of its type:

1. **Only TARSET is backed with a six-year service record.**
2. **Only TARSET has established so outstanding a performance record.**
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If you have a corrosion problem that seems unsolvable, investigate TARSET's proven advantages. Contact your nearest Pitt Chem Industrial Distributor . . . he's listed in the "Yellow Pages."

3279

PROTECTIVE COATINGS DIVISION

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A Subsidiary of PITTSBURGH COKE & CHEMICAL CO.

News—Here & There

CONTINUED FROM PAGE 7A

filter behavior under a variety of coagulation conditions."

Authors found the instrument sensitive to ±O.001 turbidity units. The instrument has been found sensitive in actual work in the Wayne County, Michigan, filtration plant.

Reprints of three articles on the subject by these authors are available from Aminco.

Research Grants Awarded for Study of Sewage

Two research contracts have been awarded for the study of advanced sewage treatment techniques by the Public Health Service, according to Dr. Luther L. Terry, Surgeon General.

The grants, totaling $46,362, went to the Polytechnic Institute of Brooklyn and Harvard University.

Both contracts involve study of different aspects of the same problem —adsorption, a process where impurities adhere in an extremely thin layer to the surfaces of solids with which they are in contact.

Polytechnic will study the practicality of using ion exchange materials in taking contaminants out of sewage effluents.

The Harvard research will center on using more commonly available adsorption materials, such as fly-ash, to determine their feasibility in removing sewage contaminants.

The contracts are part of a series to universities and industrial and private laboratories to study new and unconventional sewage treatment methods, emphasizing the use of physical and chemical scientific principles, as contrasted with the almost sole reliance upon biological principles in the past.

National Professional Engineers Recommend Merit System

The Functional Section for Engineers in Government Practice of the National Society of Professional Engineers has recommended that "the engineering profession should increase its support of actions to extend and strengthen the application of merit system principles to state-employed engineers as an expression of professional responsibility for the public interest."

This was one of several recommendations contained in a recently-published study of merit system provisions and personnel policies applicable to engineer employees in state governments. The report, "The Engineer in State Government," also suggested that the states undertake more positive measures to encourage an increase in registration among engineer employees; provide engineers with adequate numbers of supporting technical and clerical personnel; expand the range of assistance provided for advanced technical education; and expand current practices which encourage engineer employees to participate in professional society activities.

The study was undertaken to focus attention on current state practices

involving the professional employment and professional development of engineering personnel, and to encourage and stimulate improved engineering personnel policies and higher standards.

The complete survey report, "The Engineer in State Government," may be obtained from the National Society of Professional Engineers, 2029 K Street, N. W., Washington 6, D. C., at $1.00 per copy for nonmembers and fifty cents for members.

Wilbar Named ORSANCO Chairman

Dr. C. L. Wilbar, Jr., Pennsylvania state health secretary and Sanitary Water Board chairman, has been elected chairman of the Ohio River Valley Water Sanitation Commission.

Wilbar will succeed Ross H. Walker, member of the Virginia Water Control Board, as ORSANCO head on July 1. The election was held at the regular spring meeting of the commission in Pittsburgh. Dr. Wilbar has served as chairman of the finance committee and as vice-president of the Commission.

ORSANCO is the interstate agency responsible for pollution control of the Ohio River and its tributaries.

Water Levels Decline in Chicago Area

Pumpage went up and water-levels continued down during 1960 in deep wells of the Chicago region, according to a report published by the Illinois State Water Survey, scientific research division of the Illinois Department of Registration and Education.

Last year pumpage in the Chicago region increased from 88 million to 91.7 million gallons a day, the report states. This trend of pumpage, which is in excess of natural recharge, threatens potential dewatering of the water-bearing rock formations unless other sources of water are secured and conservation steps taken.

Water-level declines averaged 13 ft in 1960 and ranged from 11 ft in the Elgin area to 18 ft in the Des Plaines area.

Artesian pressure at Chicago has now declined 670 ft below the surface, according to the report, and within 20 years pumping levels exceeding 1000 ft below the surface will be common. When the first well was drilled in Chicago in 1864, water flowed freely at the surface.

Book Review

Saline Water Conversion. American Chemical Society, Advances in Chemistry Series 27. Washington, D. C.; 246 pp; $5.85 plus postage; paperbound; 1960.

The 21 papers collected in this volume were presented at a 1960 symposium of the American Chemical Society. The production of fresh water from salt and brackish waters is a leading research enterprise of today; this symposium brought together experts and proponents of many different technologies. The key question is, of course, the practical economics of each situation. Continued research is necessary. The state of knowledge in this field is up-dated by this volume, since a previous symposium in 1957. C.F.G.

TO
ELIMINATE
TASTES AND ODORS
IRON AND
MANGANESE

use your present equipment and

low-cost Carox* Potassium Permanganate

Oxidize away those two difficult water problems: *tastes and odors;* stain-causing *iron and manganese.* With CAROX Potassium Permanganate and your existing equipment, you can readily supply quality water. CAROX water treatment usually costs far less than other prevalent techniques for eliminating these problems.

Potassium Permanganate can be used effectively in large or small water treatment systems. By oxidation and adsorption it removes musty, earthy, woody, moldy, swampy, grassy, and fishy tastes and odors; destroys phenols, chlorophenols, acrylates, hydrogen sulphide, mercaptans, organic herbicides, fungicides, and insecticides. It rapidly oxidizes soluble iron and manganese which are then removed by filtration and/or sedimentation.

CAROX is easy to handle, non-corrosive, and requires minimum storage space. It is an effective biocide and provides a coagulant-aid, minimizing quantity requirements on other chemicals.

If you'd like further information about using CAROX for quality water, write Carus Chemical Company, Inc., 1377 Eighth Street, LaSalle, Illinois, or phone CA 3-1500.

*TRADE MARK

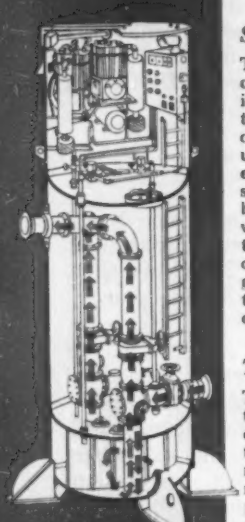
CHEMICAL COMPANY, INC.

NEW "NO-FAIL"* ELECTRODE SYSTEM FROM SMITH & LOVELESS

AN EXCLUSIVE, DEPENDABLE NEW SYSTEM DESIGNED TO ELIMINATE COMMON CAUSES OF FAILURE IN SEWAGE EJECTORS

S&L An exclusive new system to eliminate the major types of failure which sometimes occur in conventional electrode systems has been announced by Smith & Loveless.

The new "No-Fail" Electrode System has been added, at no increase in cost, to the highly dependable Smith & Loveless "Mon-O-Ject" and "Du-O-Ject" pneumatic ejector lift stations to make them the most trouble-free sewage ejectors on the market today.



System Assures Dependability

The "No-Fail" System is composed of heavy-duty rectifiers and capacitors that change alternating current to direct current, ultra-sensitive direct current relays, high-accuracy timing units and a newly designed hollow electrode. All components have been selected to provide utmost dependability and are connected in a fashion which truly provides an electrode system that, with proper maintenance, cannot fail to operate even though grounded or insulated to a degree that would cause a conventional-type ejector to fail.

Types Of Failure Explained

There are two basic types of failure that can occur with any conventional electrode system: First, the electrode tip may become coated with grease, mineral deposits and other foreign material which act as insulation and prevent the electrode from making an electrical circuit with the liquid. As a part of the new "No-Fail" Electrode System, Smith & Loveless has added a large, hollow, non-rusting electrode with greatly increased surface area to the ultra-sensitive DC relay which practically eliminates the insulation hazard to the electrode system.

Secondly, failure will most commonly occur when an electrode becomes grounded by wet stringy material or grease deposits that build up and conduct electrical current between the electrode and the sewage receiver wall. Normal maintenance cannot prevent this type of failure. It happens suddenly and in a completely unpredictable manner.

Only the Smith & Loveless "No-Fail" Electrode System will prevent failure from grounding which puts an ejector out of operation, causing the sewer system to back up.

"No-Fail" System Described

The "No-Fail" Electrode System in the Smith & Loveless "Du-O-Ject" operates in the following manner: When sewage fills one of the sewage receivers, the liquid completes the circuit from the single electrode, through the liquid, to the receiver wall which is at electrical ground potential. This energizes the DC relay which operates a three-way air valve and starts an adjustable timer. The electrical timer keeps the three-way air valve energized for a predetermined period of time while the sewage is ejected from the sewage receiver. When the timed cycle is completed, it releases the interlocks that prevent both of the receivers from ejecting at the same time, permitting the other receiver to eject when it has filled. At the end of the cycle in the other receiver, its timer will release the interlocks on the first receiver.

With the new "No-Fail" Electrode System, the timer will break the relay circuit at the end of the ejection cycle, even if the electrode is grounded, permitting the other receiver to operate when the liquid level comes in contact with the electrode in that receiver. If the electrode in either receiver becomes grounded, it will perform an ejection cycle immediately following the ejection cycle of the operative unit, whether or not the receiver is full of sewage. If the electrodes in both receivers become grounded, the "Du-O-Ject" station will operate in alternating cycles, providing continuous service, until the maintenance operator can return the ejector to normal service.

Frequently the rush of air during the ejection cycle will flush any grounding material off the electrode and remove the failure condition. When this happens, the system will return to normal operation automatically.

Lights Indicate Grounding

When grounding occurs, new "No-Fail" indicator lights on the electrical control panel tell the operator during his daily visit to the station that the unit is operating under "failure" conditions, that he should check for grounded electrodes.

With the "No-Fail" Electrode System, Smith & Loveless has again pioneered an important improvement in the sewage and industrial wastes field . . . by eliminating the major causes of ejector failure.

Available only from Smith & Loveless . . . write today for specifications.

Address: Department 20.

* Patent Pending

Smith & Loveless

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HOLDS TIGHT AGAINST SEVERE VIBRATION

W-K-M's Non-Lubricated Eccentric Plug Valve

This valve is located close to a piston pump handling a heavy and abrasive sewage sludge. Since it was installed more than a year ago in this modern sewage disposal plant, it has made a record of perfect performance — *no effects from severe vibration, no leaks, no maintenance, no repairs.*

Severe vibration was destructive to all previous valves which — frequently and at random — worked open or closed causing almost perpetual stem and line leakage. Constant attention and maintenance were required.

W-K-M's Eccentric Plug Valve is ideal where such severe conditions are involved. Its unique design allows it to maintain its open or closed position regardless of vibration or other shocks. The resilient elastomer bonded to the plug efficiently resists the abrasive action of sludges or other solid-bearing liquids.

Write for full information, P. O. Box 2117, Houston, Texas.

When So Much Depends on a Valve

. . . *Specify* W-K-M

W-K-M
DIVISION

ACF INDUSTRIES

Meetings

WHAT WHEN WHERE

1961

JULY							AUGUST							SEPTEMBER						
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30	31																			

July 16-21—New Brunswick, N. J. (Rutgers, The State University) Summer Training Institute sponsored by the U. S. Public Health Service. Courses will include air pollution, radiological health, water quality management. Write: Sylvan C. Martin, Regional Engineer, U. S. Public Health Service, 42 Broadway, New York City 4.

July 23-Aug. 4—Harriman, New York (*Arden House*) TENTH ANNUAL UTILITY MANAGEMENT WORKSHOP. Sponsored by Columbia University. Write: M. F. Garvey, 409 Engineering Bldg., Columbia University, New York 27, N. Y.

July 24-28—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*). Short Course: Recent Developments in Water Bacteriology. Write: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office Director.

Aug. 7-9—University Park, Pa. PA. WATER WORKS OPERATOR'S ASSN. Secy., Harry A. DeWire, 29 Chestnut St., Lewistown, Pa.

Aug. 7-11—Fort Collins, Colo. (*Colorado State University*) WESTERN RESOURSES CONFERENCE.

Aug. 9-11—State College, Pa. (*Pa. State University*) PA. SEWAGE & INDUSTRIAL WASTES ASSN. Secy., J. R. Harvey, c/o Pa. Dept. of Health, 996 S. Main St., Meadville, Pa.

Aug. 20-25—Blacksburg, Virginia (Virginia Polytechnic Institute) Annual short school for water works, sewerage and industrial wastes personnel. Write: Prof. W. A. Parsons, Sanitary Engineering, Holden Hall, Virginia Polytechnic Institute, Blacksburg, Va.

Aug. 27-31—St. Louis, Missouri (*Sheraton-Jefferson Hotel*) AMERICAN SOCIETY OF SANITARY ENGINEERING.

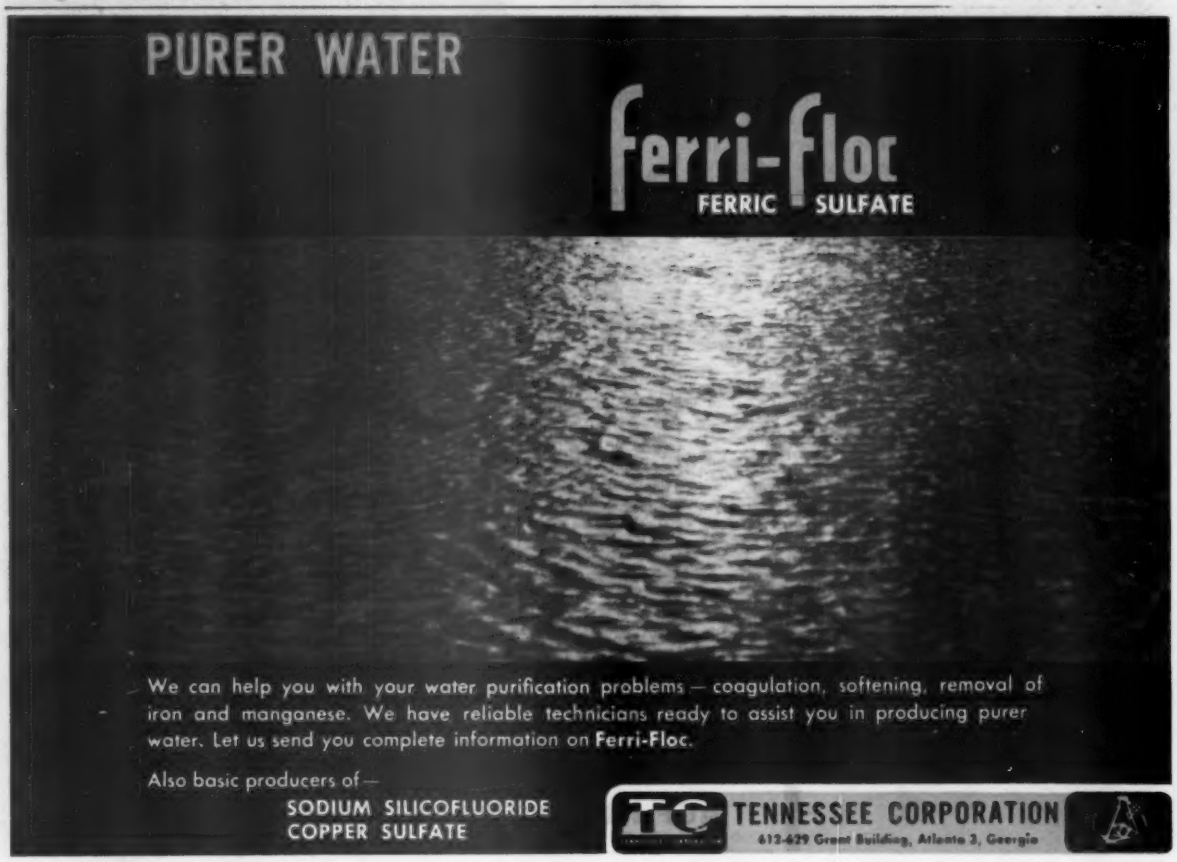
Sept. 3-8—Chicago, Ill. AMERICAN CHEMICAL SOCIETY, Div. of Water and Waste Chemistry.

Sept. 11-13—Louisville, Kentucky (*Brown Hotel*) KENTUCKY-TENNESSEE SECTION A.W.W.A. Secy., Harold F. Mount, Preston Street Road Water Dist. No. 1, 5400 Preston Highway, Louisville, Ky.

Sept. 12-Oct. 5—New Brunswick, N. J. (*Rutgers University*) Short Course: Water Works and Filter Plant Operation. Contact Dean, College of Engineering, Rutgers, the State University, New Brunswick, N. J.

Sept. 13-15—Saranac Lake, N. Y. (*Saranac Inn*) N.Y. SECTION A.W.W.A. Secy., Kimball Blanchard, Neptune Meter Co., 2222 Jackson Ave., Long Island City 1.

CONTINUED ON PAGE 16A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We can help you with your water purification problems — coagulation, softening, removal of iron and manganese. We have reliable technicians ready to assist you in producing purer water. Let us send you complete information on Ferri-Floc.
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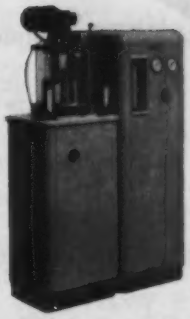
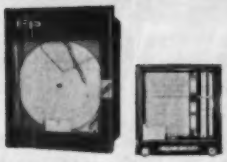
Chlorinators, Ammoniators
Sulfonators

Residual Analyzers

Chlorine Dioxide Generators

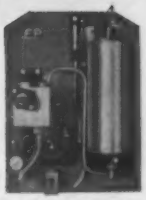


Activated Silica Feeders



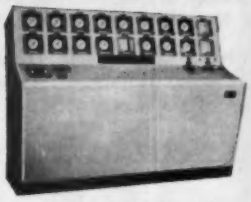
Recorders & Controllers
for flow, pressure,
temperature, level, pH

Magnetic Flowmeters

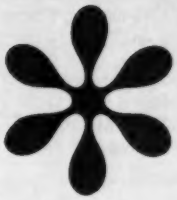


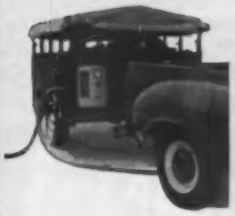
Fluoridators

Evaporators

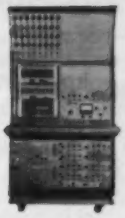


Control Consoles
Miniature Instrumentation





Mobile Chlorinator Service



Systems Studies
with Computers

*For Automation of Water Treatment . . .

Complete Instrumentation and Chlorination Equipment

Why shop around for system components? Save time and money as you design automation for your water plant—and gain years of trouble-free service after installation—with F&P instrumentation and chlorination systems. Flowmeters, recorders, controllers and chemical treatment equipment can all be selected as a coordinated system—from a single, reliable source! And the unusually wide F&P selection means we can recommend without prejudice.

For basic information or specific suggestions, write Fischer & Porter Company, 171 Fischer Road, Warminster, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto.

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CHLORINATION AND INSTRUMENTATION

Meetings CONTINUED FROM PAGE 14A

Sept. 13-15—St Paul, Minn. (*Hotel Lowry*) NORTH CENTRAL SECTION A.W.W.A. Secy., Carl A. Flack, Water Dept., 216 City Hall, St. Paul 2, Minn.

Sept. 17-21—Poland Spring, Maine. Annual Convention NEW ENGLAND WATER WORKS ASSOCIATION.

Sept. 20-22—Rapid City, South Dakota (*Sheraton-Johnson Hotel*) JOINT MEETING So. DAK. WATER & SEWAGE WORKS CONF., So. DAK. SECTION A.W.W.A. and So. DAK. WATER POLLUTION CONTROL ASSN. Secy., Don C. Kalda, So. Dak. Water and Sewage Works Conf.. Div. of San Engrg., State Board of Health, Pierre. So. Dak.

Sept. 24-27—Lake Placid, N. Y. AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

Sept. 24-27—Minneapolis, Minn. (*Municipal Auditorium*) PUBLIC WORKS CONGRESS & EQUIPMENT SHOW. Write: American Public Works Assn., 1313 E. 60th St., Chicago 37, Ill.

Sept. 27-29—Milwaukee, Wis. WISCONSIN SECTION A.W.W.A. Fortieth Annual Conf. Secy., Harry Breimeister, 507 Municipal Bldg., 841 N. Broadway, Milwaukee 2, Wis.

Oct. 1-3—Springfield, Missouri (*Kentwood Arms Hotel*) MISSOURI SECTION A.W.W.A. Secy., Warren A. Kramer, Chief, Water Supply, Div. of Health, State Office Bldg., Jefferson City.

Oct. 1-3—Springfield, Missouri (*Kentwood Arms Hotel*) MISSOURI WATER POLLUTION CONTROL ASSN. Secy., Jack K. Smith, Old Post Office Bldg., 112 W. High, Jefferson City, Mo.

Oct. 2-4—Taos, New Mexico. ROCKY MOUNTAIN SECTION A.W.W.A. Secy., H. F. Kepner, 550 Alcott, Denver 4, Colorado.

Oct. 4-6—Roanoke, Virginia (*Hotel Roanoke*) VIRGINIA SECTION A.W.W.A. Secy., Edward H. Ruehl, R. Stuart Royer & Assocs., 15 W. Cary St., Richmond 20.

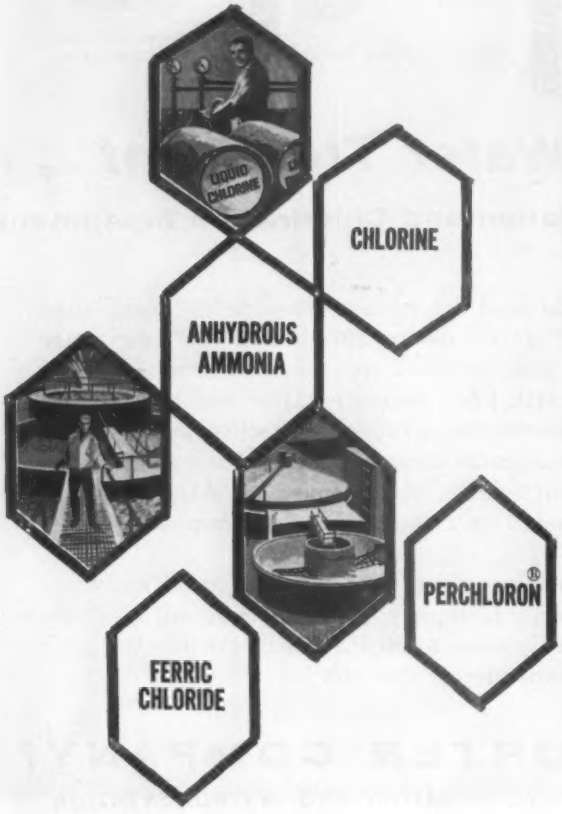
Oct. 8-11—Biloxi, Miss. (*Buena Vista Hotel*) ALA.-MISS. SECTION A.W.W.A. Secy., Ernest Bryan, McWane Cast Iron Pipe Co., Box 2601, Birmingham, Ala.

Oct. 9-12—Milwaukee, Wis. (*Schroeder Hotel*) THIRTY FOURTH ANNUAL MEETING WATER POLLUTION CONTROL FEDERATION. Secy., Ralph E. Fuhrman 4435 Wisconsin Ave., Washington 6, D. C.

Oct. 15-18—San Antonio, Texas (*Hilton Hotel*) SOUTHWEST SECTION A.W.W.A. Secy., L. A. Jackson, Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

Oct. 17-Nov. 9—New Brunswick, N. J. (*Rutgers University*) Short Course: Sewage Disposal and Plant Operation. Contact Dean, College of Engineering, Rutgers, The State University, New Brunswick, N. J.

Oct. 18-20—Cedar Rapids, Iowa (*Roosevelt Hotel*) IOWA SECTION A.W.W.A. Secy., Wilbur E. Bjork, Des Moines Water Works, 1003 Locust St., Des Moines.



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PENNSALT CHEMICALS

FOR EFFECTIVE, EFFICIENT WATER AND SEWAGE TREATMENT

Whether your needs are a few cylinders and drums or multiple unit rail cars . . . you can be sure of dependable chemicals . . . and fast, reliable delivery every time.

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Pennsalt Chemicals
ESTABLISHED 1850

One of Southern California's largest home developments, Eastgate, assures low-cost, efficient water service for its 2250 homeowners with "K&M" Asbestos-Cement Pressure Pipe.

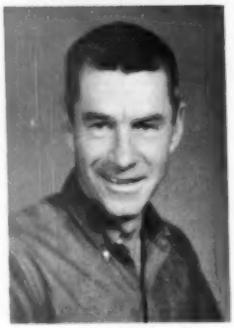
22 MILES OF "K&M" ASBESTOS-CEMENT PRESSURE PIPE ASSURE

dependable water service for a spanking new city of 10,000!

Modern cities like Eastgate spring full-grown from the earth—complete with homes, schools, shopping center and even a hospital. To make such a city a reality calls for modern methods and modern materials, such as "K&M" Asbestos-Cement Pressure Pipe. This rugged pipe was the builder's choice for its freedom from maintenance and for its durability. He knows today's particular home buyers demand materials that function without failure for years and years. Another important factor was the ease of installation and handling "K&M" Asbestos-Cement Pressure Pipe offers. Robert Kennedy, of Kennedy Pipe & Supply Company, tells you, in his own words, how "K&M" Asbestos-Cement Pressure Pipe helped him adhere to a tight schedule.

"THE 'K&M' FLUID-TITE® COUPLING HELPED US LAY MORE PIPE PER HOUR!"

"We had no trouble keeping up with the builder's tight schedule with 'K&M' Asbestos-Cement Pressure Pipe and the 'K&M' FLUID-TITE Coupling. All we had to do was lubricate the pipe end, and slide it into the coupling. This gave us a joint tight under all operating conditions. We didn't need any heavy machinery or coupling pullers. 'K&M' Pipe was lightweight and easy to handle, which permitted us to work smoothly. It reduced our installation time and costs considerably."



Robert Kennedy, President, Kennedy Pipe & Supply Company, Paramount, Calif.

After it's in the ground, "K&M" Asbestos-Cement Pressure Pipe is practically indestructible. It won't tuberculate. This assures the taxpayer of the same water flow and pressure years later, that he had when his home was new. Pumping costs remain low. Joints stay watertight. In addition, this pipe resists corrosion, and is immune to electrolysis.

For more information write to: Keasbey & Mattison Co., Ambler, Pa.

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Keasbey & Mattison at Ambler

The light weight of "K&M"® Asbestos-Cement Pressure Pipe permits you to lay most sizes by hand . . . and reduces shipping costs.

Assembling the exclusive, patented "K&M" FLUID-TITE® Coupling and Pipe takes but an instant.

"I oughta wring that pump salesman's neck!"

"They're shipping next week, he says . . . but I've heard *that* old line for six weeks! Sure, my pump's a 'special', but *he* oughta know how long it takes to build one. We've geared all our plans to his phoney promise, and now the Mayor's raising the roof! After this, we'll stick with outfits who've got enough 'big-pump' savvy to *deliver on time!*"

The ability to deliver on time is another of the extra values you get when you deal with Allis-Chalmers. Industrial Equipment Division, **Allis-Chalmers,** Milwaukee 1, Wisconsin. A-1510

ALLIS-CHALMERS DELIVERS ON TIME

At Allis-Chalmers we have accepted penalty clause contracts because we know that in 99% of the cases we can deliver. That 99% is an actual fact, based on many years of experience in supplying pumps to municipalities. We have the resources and the manufacturing facilities to get pumps delivered when promised.

ON THE NATIONAL SCENE

TEN YEARS UNSUCCESSFUL NEGOTIATIONS aimed at halting Maysville, Ky., from dumping raw sewage into the Ohio River ended when the Kentucky State Water Pollution Control Commission ordered the city to submit a definite plan for building a sewage treatment plant. Deadline for submission of the plan is July 18. Failure of Maysville to comply with the order could lead to court action—which could ultimately include $1,000 per-day penalties.

USDA OK'S BEAR-TILDA BOGUE WATERSHED PLANNING.—Another step toward construction of the multi-million dollar Bear-Tilda Bogue Watershed project in Mississippi has been taken as the U. S. Department of Agriculture authorized planning assistance. Planning for the $2-million project is scheduled to begin in August and is expected to take about nine months. The watershed protection and flood prevention project will affect approximately 108,000 acres and will be the largest such project in Mississippi.

THE NEW JERSEY HEALTH DEPARTMENT says progress is being made to rid Raritan Bay of pollution by municipal sewer plants. Two communities are about ready to begin construction on sewer plant enlargements, while a third is under orders to change its sewer treatment system operations. The Bay has been closed down to shellfishing on orders from Health Commissioner Dr. Roscoe P. Kandle, after statistics showed a possible relationship between eating raw clams, from human effluent polluted waters, and hepatitis, a serious liver disease.

A COMPROMISE IS IMMINENT in the three-year old battle between Cleveland, Ohio, and 23 surrounding suburbs. The issue at stake is Cleveland's 1958 decision to raise suburban sewer users' rates 150 percent, while holding the city's user rate steady. The new proposal would lower suburban rates substantially and raise city rates by 56 percent. Settlement of the controversy would also enable Cleveland to proceed with construction of almost $20-million worth of new facilities in the next five years, it was reported.

A SEWAGE SLUDGE DISPOSAL UNIT THAT GENERATES ITS OWN HEAT will be installed soon in South Milwaukee, Wisconsin—the fourth such installation in this country. The unit, which employs the "wet air oxidation" method was built by the Zimpro division of Sterling Drug, Inc. According to Neal Seegert, v.p. of the Zimpro division, 5,000 gallons of solid sewage can be processed per day in the 40 ft high by 3 ft diameter reactor. Oxidation takes place at a temperature of between 450 and 470 degrees, under a pressure of 500 psi. After oxidation, the remaining water is used to heat the incoming sludge.

IF YOU THINK YOUR TOWN IS DIRTY, pity the plight of residents of New York City. According to a report by the New York Department of Air Pollution Control, an average of 725 tons of soot falls on the city every day. Manhattan proper was the sootiest of the city's five boroughs with a fall rate of 100 tons per square mile per month in 1960. But the department is still optimistic; in 1944 the soot fall was twice as much as last year.

THE TEXAS HOUSE OF REPRESENTATIVES has given its approval to a bill to set up a state-wide pollution control board. Under the bill, the state would use $195,000 in state and federal funds for the program to curb pollution of the state's lakes, streams and underground water. The bill now goes to the State Senate.

"HYDRONAUTS" is the new name for America's unsung water scientists suggested by Senator Robert S. Kerr (D-Okla.). Keynoting the National Watershed Congress in Tuscon, Arizona, Sen. Kerr called for "due recognition by a thankful and grateful government" for these "heroes of conservation." He also reiterated President Kennedy's comment that a practical way of converting salt water to fresh water would dwarf space exploration as a contribution to human welfare.

A CONTRACT FOR RESEARCH on a new technique to remove contaminants in water that remain after treatment in sewage disposal plants has been awarded to

JULY, 1961

Radiation Applications, Inc., research division of Schenley Industries. The year-long project will investigate foaming, which causes bubbles of air to rise through a liquid containing synthetic detergents to form a high concentration of the contaminant materials on the surface which can be removed.

A FIFTEEN MINUTE COLOR MOVIE on sewage collection and disposal in the suburban Maryland area outside Washington, D. C. is scheduled for completion this summer by the Washington Suburban Sanitary Commission. The film will describe the operation of the WSSC sewage system and will provide background on the importance of well-planned sewage disposal to the health and growth of the suburban area. Like the movie "Priceless Water." produced in cooperation with AWWA last fall, the new film is designed for civic group, school, and business organization use and should be a powerful community relations tool.

A NEW TESTIMONIAL FOR FLUORIDATION has been revealed in a comprehensive analysis of Washington, D.C.'s nine-year experience, covering almost a million dental examinations. During the period, the incidence of caries has fallen by more than 60 percent. There is also strong evidence that the benefits are of a lasting nature, furthering stronger, healthier teeth throughout the lifetimes of those exposed at an early age to the chemically treated water.

A BOSTON MANUFACTURER of equipment for public water supply purification has entered the water bottling business. While increases in bottled water use have been steady in recent years, much of the growth of the industry may be attributed to new uses, such as in steam irons. But a company official has come up with a new reason for increased bottled water use. He suggests that while water may be pure when it leaves the utility, there is much old piping in dwellings, at least in New England, that water pollution within the buildings themselves is becoming a problem.

"UNTHINKABLE TO RETURN SEWAGE TO LAKE.— Clarence W. Klassen, chief sanitary engineer of the Illinois State Health Department, said it would be "unthinkable" to force Chicago to return its treated sewage to Lake Michigan. Speaking at the two-day conference on water pollution held by De Paul University, Mr. Klassen declared: "To consider putting a billion gallons of treated sewage into the source of drinking water for 5.5-million people is unthinkable. It has no precedent in public health." Chicago's diversion of Lake Michigan water for sanitary purposes is under fire currently by neighboring Great Lakes cities and states.

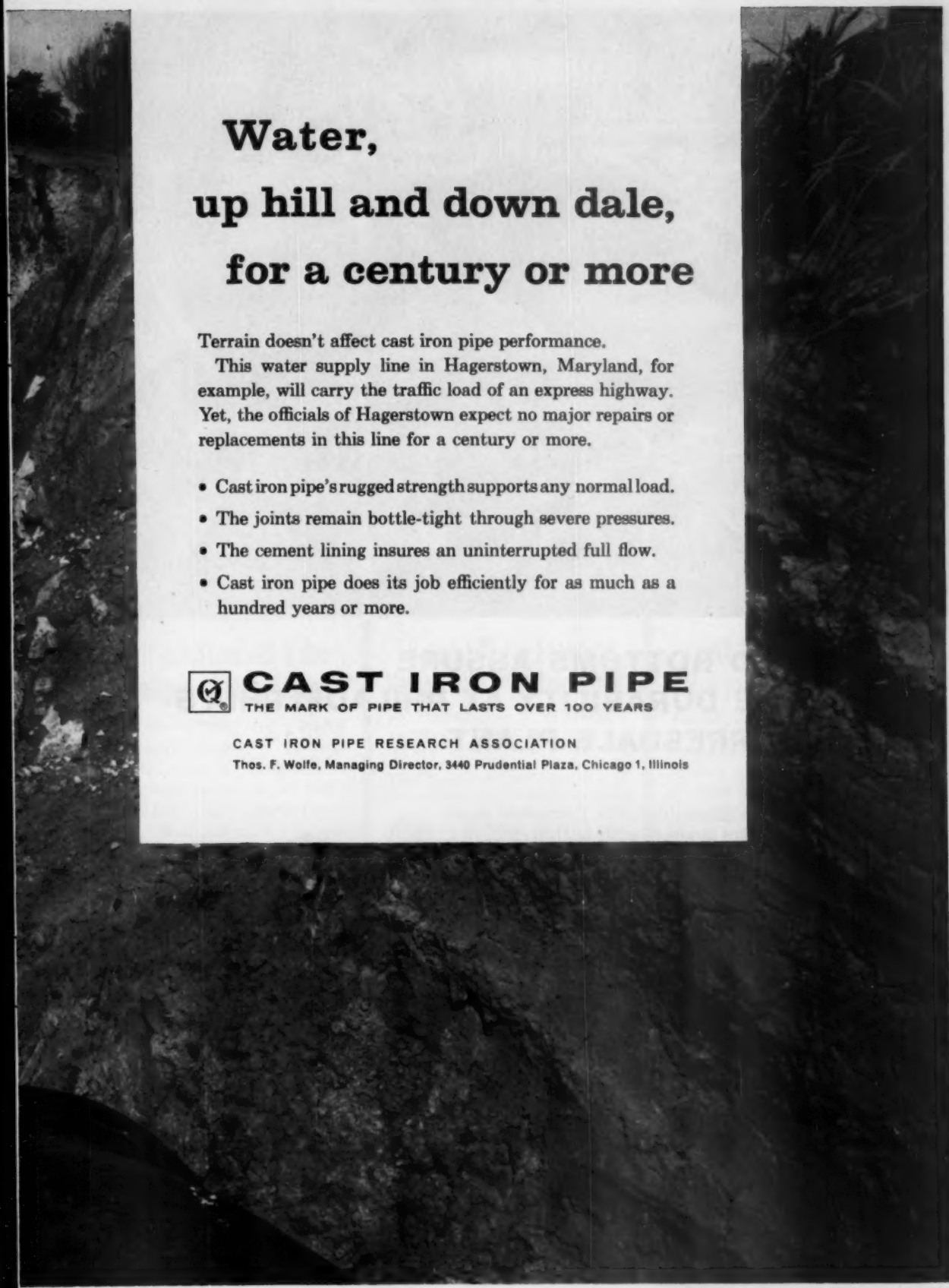
A METROPOLITAN SANITARY DISTRICT BILL, which health authorities said was urgently needed to solve a growing sanitation problem arising primarily from contamination of suburban wells by septic tank effluent, has failed to pass the Minnesota legislature. The proposed legislation, as introduced to the legislature, would have created a six-county metropolitan sanitary district that would have bought out the present Minneapolis-St. Paul Sanitary District.

A 108-IN. DIAMETER ASPHALT-LINED CORRUGATED METAL PIPE, the largest of its type ever used in the Los Angeles area, has been serving as a sewer bypass during construction and modification of Los Angeles' Hyperion Sewage Treatment Plant. The big pipe was fabricated by Pacific Corrugated Culvert Co.

ORDERLY DEVELOPMENT of Pennsylvania's natural resources, the most critical of which is water, has been urged by 12 members of the Penn State University College of Agriculture. To bring added attention to the problem, the committee proposes a state-wide conference of all interested parties—state, Federal, and private agencies—to work out a solution.

A $12-MILLION PRICE TAG has been placed on construction of Salt Lake City's proposed sewage plant, a new sewer trunk line and a connecting interceptor line. A detailed report of costs was prepared for the Citizens Advisory Committee on City Planning and Capital Improvements for possible inclusion in the city's forthcoming capital improvement bond issue. Construction of the facilities has been listed as one of the city's most urgent needs by a number of advisory committees in recent years.

RHODE ISLAND'S GOVERNOR NOTTE has requested the state General Assembly to approve a bill providing a $4-million bond issue to acquire land in the western part of the state for future development of two water reservoirs. While cries for economy budgeting are loud, the ever growing water problems, coupled with continued population expansion, make action now advantageous, before water shortages in the western part of the state become acute.



Water, up hill and down dale, for a century or more

Terrain doesn't affect cast iron pipe performance.

This water supply line in Hagerstown, Maryland, for example, will carry the traffic load of an express highway. Yet, the officials of Hagerstown expect no major repairs or replacements in this line for a century or more.

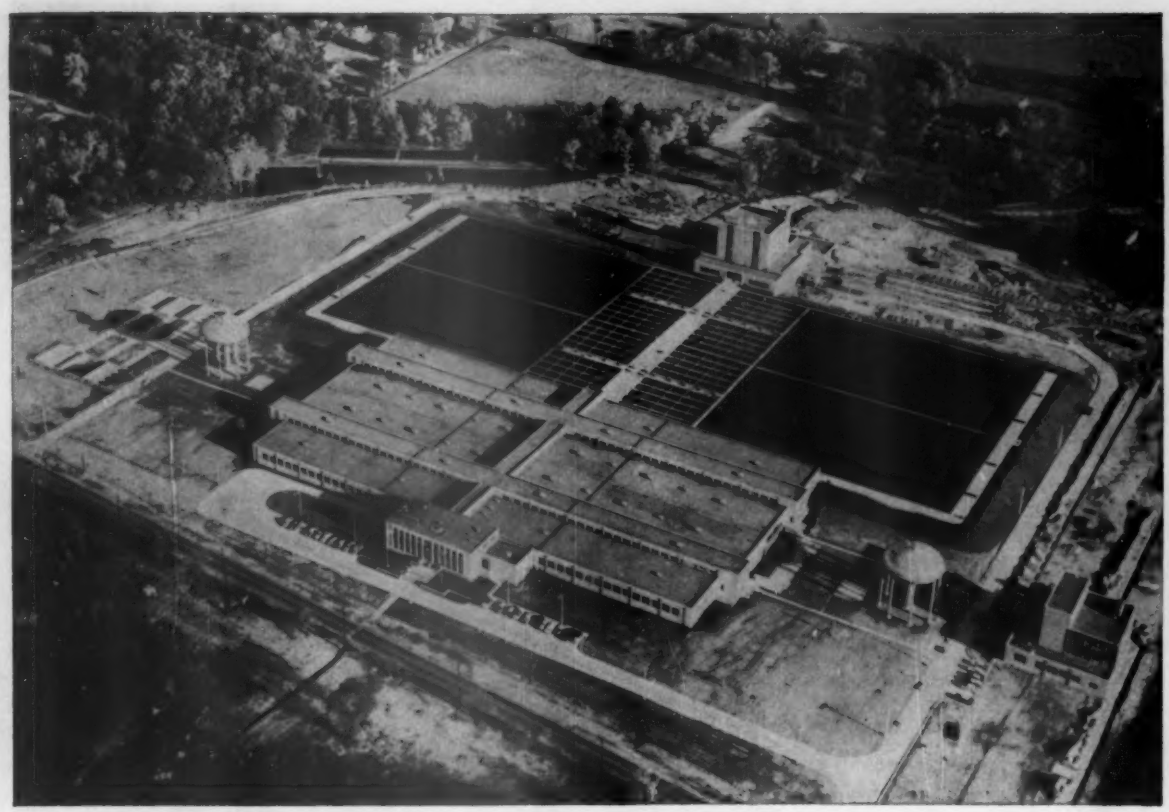
- Cast iron pipe's rugged strength supports any normal load.
- The joints remain bottle-tight through severe pressures.
- The cement lining insures an uninterrupted full flow.
- Cast iron pipe does its job efficiently for as much as a hundred years or more.

CAST IRON PIPE

THE MARK OF PIPE THAT LASTS OVER 100 YEARS

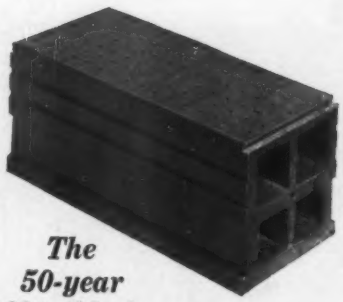
CAST IRON PIPE RESEARCH ASSOCIATION

Thos. F. Wolfe, Managing Director, 3440 Prudential Plaza, Chicago 1, Illinois



LEOPOLD BOTTOMS ASSURE LIFETIME DURABILITY AT PHILADELPHIA'S NEW TORRESDALE PLANT

Built at a cost of $25 million, the Torresdale water treatment plant is a model of push-button efficiency. Designed to provide 282 M.G.D., with a maximum capacity of 423 M.G.D., it shares the burden of water supply with the smaller Queen Lane and Belmont plants. Incidentally, Leopold bottoms are in use at Belmont and have been installed at the newly reconstructed Queen Lane plant as well. Individual Leopold glazed tile filter blocks are made of de-aired fire clay . . . they can't rust, absorb water or crumble. Tuberculation can't form on their smooth finish, which is impervious to acid and alkali. More bonus advantages: no supporting concrete structures are needed, and only a shallow depth of small-sized gravel is required. The proof is in the use . . . Leopold blocks are installed at more than 500 new and rehabilitation projects throughout the nation. Write for facts and figures today.



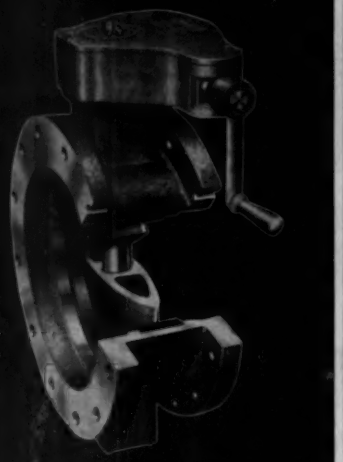
The 50-year filter block

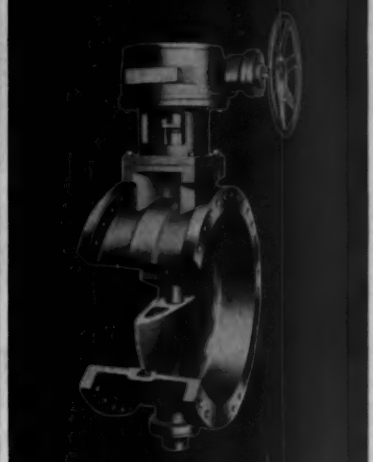
Leopold

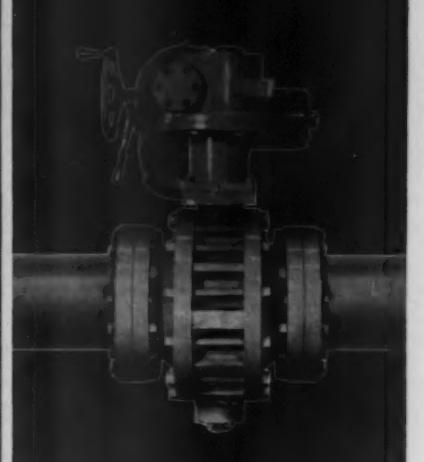
F. B. LEOPOLD CO., INC., Zelienople, Pa.

Exclusive Canadian Representative:

Now! PRATT STANDARD RUBBER SEAT VALVES FROM VACUUM TO 250 psi







150 psi Standard Valve Flanged or Monoflange

This Henry Pratt valve is loaded with extra values . . . the most *rugged construction* available . . . lower costs due to complete standardization . . . and economical *space savings* thru new narrow face-to-face dimensions in classes up to 125 psi . . . *new sidewinder operator* with manual, cylinder and motor types.

Highly versatile—available in 2 flange or monoflange types, with floor stand or extension bonnets, and completely sealed operators for buried service.

For AWWA classes 25-8 thru *125-16* in sizes 4″ thru 20″.

Write for Bulletin 6-B.

50 and 125 psi Standard Valves with adjustable seat

For the first time, 50 psi Standard Valves are available with economical narrow face-to-face dimensions thru the full 50-16 classification. The 125 psi Standard Valves in wide face-to-face offer traditional Pratt ruggedness in classes 50-8 thru 125-16. In all classes the valve seats are factory adjusted around their perimeter for the most precise fitting of disc to seat, a feature that offers:

Easier operation—with a precisely fitted seat.

Longer Life—accurate control of disc-seat interference provides tightness without wear.

Bubble-tight operation up to 150 psi.

Easy field adjustment . . . seats can be adjusted or even replaced without dismantling the valve or removing it from the line . . . and the seat fitting will be factory accurate.

Sizes 24″ thru 72″.

Described in Bulletin 6-B.

Pratt Rubber Seat Ball Valve for 150 and 250 psi

Resilient seating has now been applied to ball valves—putting the time-proved advantages of this seat to work at higher pressures and velocities than ever attained before.

The Henry Pratt Ball Valve offers bubble tight performance for ball or cone valve applications plus these definite advantages: *less weight, smaller size, lower operating torques* than similar valves . . . and *no more pressure drop than equivalent length of pipe.* The rubber seat will not bind or stick and compensates for line distortion. One man operation against full line pressure.

Complete line of operators and accessories. Ideal for buried service with enclosed operator. Sizes 10″ thru 48″.

Write for Bulletin BA-1-B.

Creative Engineering for Fluid Systems

HENRY PRATT COMPANY
319 West Van Buren Street • Chicago 7, Illinois
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HENRY PRATT®

Announcing

The **METER** *that took the time*

TO SAVE MILLIONS FOR THE WATER INDUSTRY

1 PROTECTS YOUR PRESENT INVESTMENT

because your older Tridents can be converted simply by replacing standard parts with new Model 60 parts, giving you the advantages of this new meter at minimum cost.

2 PROTECTS YOU FROM FUTURE OBSOLESCENCE

because it was designed and manufactured in strict accordance with Neptune's "interchangeability" policy. Will not be obsoleted by developments that are now on the drawing boards.

3 PROTECTS YOU AGAINST UNNECESSARY REPLACEMENT COSTS

because it permits you to easily and quickly repair minor damage without having to scrap major units.

4 PROTECTS YOU AGAINST LOST REVENUE

because with its easily accessible change gears, minor variations in registration can quickly be calibrated to compensate for worn parts.

This new sealed meter will save millions of dollars for TRIDENT METER USERS over the next few years.

SEE FOR YOURSELF HOW IT CAN WORK FOR YOU...

New

TRIDENT *model* 60

Water Meter

THE SEALED METER

that protects your investment because

it can be repaired, reset and calibrated

economically in your own shop,

WITH COMPLETE INTERCHANGEABILITY OF PARTS...

neptune METER COMPANY

Liquid Meter Division / 47-25 34th St., Long Island City, N.Y.

TRIDENT

TRIDENT PROGRESS AGAIN PROTECTS

Here is the meter that makes progress a pleasure... everything that's new... all the advantages of the most modern sealed constructions, with a big Neptune plus: It can be repaired, reset and recalibrated in your

New non-fogging sealed register

HERMETICALLY SEALED... immune to moisture, flooding, mud, dust. Won't fog. Wears longer.

REPAIRABLE. No need to throw away your whole register investment just because of an accident to one part. By removing only three screws the register can be completely disassembled. Can easily be re-sealed and re-dehumidified.

REPLACEABLE CRYSTAL... sturdy glass crystal is mighty tough, but if it *should* break you can replace it for just a few cents.

POWERFUL MAGNETIC DRIVE... tamper-free ... elimi-

Can be reset to zero

THE ONLY RESETTABLE SEALED REGISTER... a boon to utilities who turn repaired meters back to zero

Registration can be adjusted

CHANGE GEAR FEATURE, exclusive among hermetically sealed meters, permits adjustment of registration. No need to lose income ... no need to replace expensive components just because of a

New totally enclosed gear train

WATER NEVER TOUCHES GEARS. No corrosion ... less "drag"... no danger of freezing. Means long, long accurate life even in difficult waters.

NO WATER LEAKS, NO OIL LEAKS.

SEALED AND LUBRICATED FOR LIFE.

POWERFUL SHIELDED MAGNETIC DRIVE. A permanent magnet inside the sealed unit is driven by a mag-

Trident quiet flat-disc measuring element

THE FINEST, MOST WEAR-RESISTANT AND TROUBLE-FREE WATER MEASURING PRINCIPLE known to the science of metering. Remarkable sensitivity to "leak type" low flows. Unequaled simplicity. Precision ma-

model 60

YOUR METER INVESTMENT...

own shop... at low cost, with no special skills required. Parts are interchangeable ... you can easily convert and modernize your older Tridents at far less than "scrap and replace" costs.

nates all rotary seals or packing glands which might cause leaks.

SWEEP TEST HAND...customer can see it move, prove to himself whether leaks are wasting water in his house. By using simple Neptune test ring which sits on top of register, meter can be tested without any disassembly.

FITS OLDER TRIDENTS, TOO. Permits low-cost modernization of all your Trident disc meters from ⅝ to 2 inches. When you standardize on Trident you are sure to save time and money and protect the capital you have invested.

before placing them in customers' houses... good public relations.

little wear or mineral deposits. Keep them working years longer by use of inexpensive change gears to restore accuracy.

net below. Shielded against tampering. Cannot be disabled by magnetic particles that may accumulate over years.

FITS OLDER TRIDENTS, TOO. Interchangeable with standard Trident gear trains in all ⅝, ¾, and 1-in. Trident Disc Meters made in the past 50 years.

chined to minimize effects of wear ... keeps its accuracy longer. Quieter, with Neptune thrust roller and bearing plate to prevent piston slap. Replaceable half-balls. Sand ring keeps abrasives away from spindle, block, and ball.

Now all these TRIDENT combinations to fit your needs

Trident Split-case meter with Model 60 sealed register and Model 60 gear train.

Trident with Model 60 sealed register and standard oil-enclosed gear train.

Trident with standard register (round reading or straight reading) and new Model 60 sealed gear train.

Trident with standard register (round reading or straight reading) and standard oil enclosed gear train.

Plus the same combination in Trident Frost-proof meters for colder climates where freezing is a problem.

Trident INTERCHANGEABILITY protects your investment

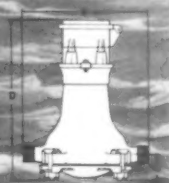
...now and in the future.

Suddenly all your Tridents are modern as tomorrow. Trident's exclusive interchangeability lets you substitute the new Model 60 Sealed Register and/or Model 60 Sealed Gear Trains in any of your older Trident Meters. When, after test, you decide one or both of these new magnetically driven sealed units will reduce overall operating costs in your system, you can immediately start a program of modernizing your older meters.

Trident Model 60 Dimensions & Rates of Flow

SPLIT CASE METERS

FROST-PROOF METERS



SIZE	A LENGTH IN.	WIDTH IN.	C BASE TO CENTER-LINE OF PIPE	D HEIGHT, IN.		*APPROX. WEIGHT LBS.	RATE OF FLOW
				MODEL 60 REGISTER	STANDARD REGISTER		
⅝ (and ⅝ x ¾)	7½	5	1	8½	7¾	10½	20
¾	9	5⅜	1 3/16	9	8⅛	12	30
1 (and 1 x 1¼)	10¾	7½	1⅝	9½	8¾	20½	50
⅝ (and ⅝ x ¾)	7½	5½	1¾	9⅜	8¾	11½	20
¾	9	6	1¾	9⅜	8¾	15½	30
1 (and 1 x 1¼)	10¾	9⅜	2	10¼	9½	27½	50

*Weight varies by a few ounces depending on register and gear train selected.

neptune METER COMPANY

Liquid Meter Division

47-25 34th St., Long Island City 1, N. Y.

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FORM NO. 426 PRINTED IN U.S.A. 30M/12/60

Everything that is newest in a water meter is in

TRIDENT

model **60**

...and interchangeability can work for you now!

All the advantages of the New Model 60 can be built into your system right now. The "interchangeable unit" principle on which all Trident Meters are designed and manufactured makes it possible to integrate the Model 60 into your present system without jeopardizing present or future investments in meters.

At very low cost, all present users of Trident Meters can have all the advantages of a sealed meter by just adding the Model 60 Register and Sealed Gear Train to any Trident.

When you order Trident Meters, the investment of your company or your taxpayers (for which you are responsible) is protected all ways . . . past, present and future. You don't need to anticipate scrapping Model 60 meters because of *later* improvements. The Model 60 has today anticipated and is adaptable to future developments not yet off the drawing boards.

And for those users who prefer the standard Trident Meter, these fine meters will still be manufactured. Standard gear trains and registers will be available as before, both as new meter components and as repair parts.

TAKE THE FIRST STEP TODAY...

The new Model 60 can produce some impressive savings in your operating costs . . . eliminate lost revenue . . . and give you better over-all operating efficiency. A discussion with a Neptune representative will show you how Trident Model 60 meets your specific requirements. For further information write or phone Neptune Meter Company, Liquid Meter Division, 47-25 34th Street, Long Island City 1, N. Y. or the nearest Neptune District Office.

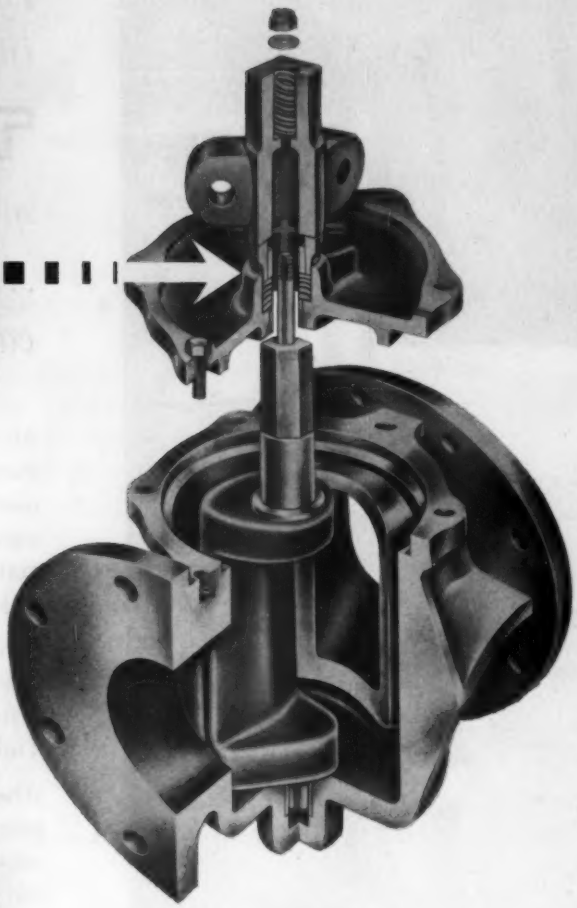
LIFT OUT FOR YOUR FILES:

THIS FOUR PAGE INSERT GIVES YOU QUICK BUYING FACTS.

Another Advantage of DeZurik Valves:

SELF-ADJUSTING STEM-PACKING QUICKLY CHANGED

WITHOUT REMOVING PLUG FROM VALVE!!!



One major reason why **DeZurik Eccentric-Action Valves** are preferred in so many sewage services is their self-adjusting, leak-free stem seal. Multiple "chevron" packing is held under constant spring pressure, maintaining 100% sealing efficiency without the slightest leakage and without maintenance during long usage. The packing rarely requires changing, but when it does **YOU CAN CHANGE IT QUICKLY, EASILY,** at reasonably low pressures, **WITH THE VALVE STAYING RIGHT IN SERVICE.** You need not close down or drain the line.

Think of the tremendous advantage on sludge, for example—you avoid the serious grief and mess and costly shutdown involved in repacking other valves. That is just one of the finer features of **DeZURIK VALVES**—here are more of them:

Positive leak-free shut-off

...On any flow from air to solid

Easy, smooth operation

...Regardless of Cycle-Frequency

No lubrication or fuss

...Virtually no maintenance needed

No stem freeze-up or bind

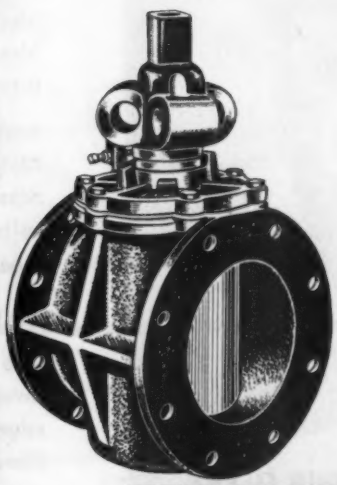
...Plus Replaceable Stem Packing

Resistance to corrosion

...Full range non-corrosive materials

Exceptional long life

...Prolonged performance in toughest use



DeZURIK VALVES are produced in a full range of sizes from ½" thru 30". A wide variety of end-connections and actuators. DeZURIK Representatives in all areas. CATALOG ON REQUEST.

DeZURIK CORPORATION
SARTELL, MINNESOTA

It's great
to get home...
even the water tastes better!

AQUA
NUCHAR
ACTIVATED
CARBON
for taste and odor control

Are the folks in your community glad to get home to the water you serve? They are if it is *consistently* as *palatable* as it is pure.

You can be sure of serving the best-tasting water if you faithfully follow the practice of daily threshold odor tests to detect and accurately measure tastes and odors as they form, and then control them with AQUA NUCHAR.

Due to its incredible porosity, AQUA NUCHAR has strong surface affinity for taste-and-odor-forming substances. Extremely low average concentrations quickly entrap troublesome matter and remove it by adsorption. With AQUA NUCHAR, *consistent palatability costs just pennies per day!*

Our field representative will gladly discuss your problem with you and arrange for a survey of your plant.

West Virginia Pulp and Paper
INDUSTRIAL CHEMICAL SALES DIVISION

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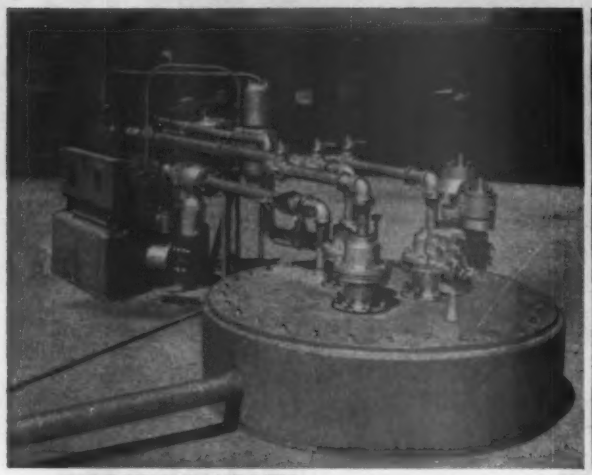
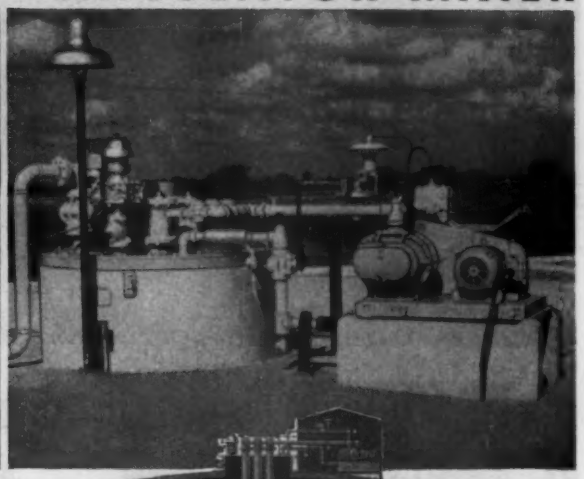
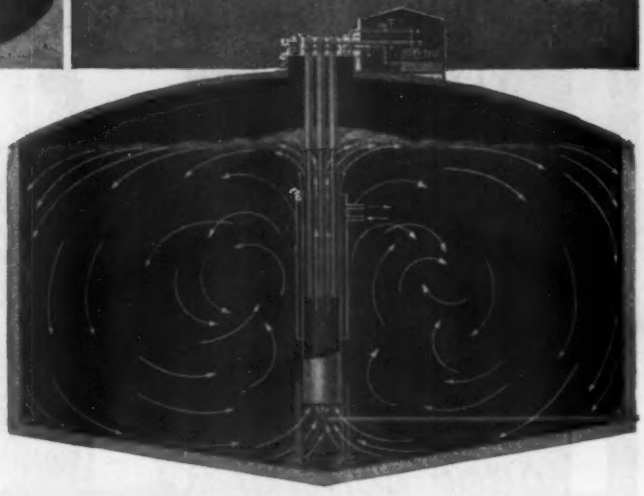
complete homogenizing GASLIFTER DIGESTER CIRCULATOR-MIXER







DIRECTUBE HEATX
— for economical sludge heating

GAS LOCKING CHAMBER
— for safe, easy inspection

GAS-LIFT PRINCIPLE
— for powerful over-all stirring

All Gaslifter equipped digesters have the common advantage of better, uniform digestion. Contents are liquefied, completely circulated and diffused — even dense sludges, surface grease and scum. Bottom shoals eliminated. The eductor tube, gas-lift principle creates a powerful over-all roll within the digester which sweeps all areas resulting in complete homogenizing.

Positive, powerful roll allows for economical intermittent operation since steady state homogenization takes place within 15 minutes.

Rapid gasification is induced while volatile acids remain low.

Incoming green sludge is readily admixed so as to accelerate its digestion permitting maximum loading. Methane yield is increased and good supernatent obtained.

Built-in gas locking chamber permits safe withdrawal of the gas diffuser from within the lift tube without digester shut-down or danger.

The DIRECTUBE HEATX-GASLIFTER assembly combines economical, positive temperature control and efficient digester operation. DIRECTUBE HEATX is shop fabricated as an integral part of the GASLIFTER and requires only hot water recirculation lines from a Walker Sewage Gas Boiler. Optimum temperature requirements are easily maintained. Available with manual or automatic controls.

Write for bulletins 24-S-82 and 25-S-91.

Top Left — LAS CRUCES, N.M. — 8000 gpm GASLIFTER in 50' dia. digester with fixed cover. R. A. Smith, Supt. Gordon Herkenhoff & Assoc., Albuquerque, Cons. Engrs.

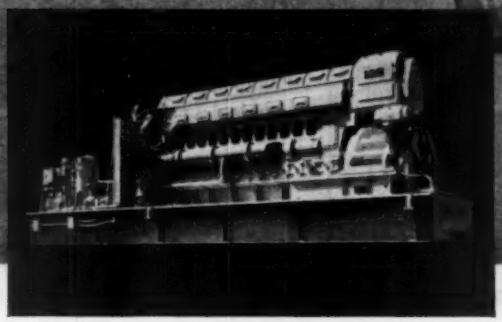
Top right — SACRAMENTO COUNTY, CALIF. (San. Dist. #3) GASLIFTER in 70' dia. digester with fixed concrete cover. Mr. Norman Farnum, Supt. Dewante & Stowell, Sacramento, Cons. Engrs.

WALKER PROCESS EQUIPMENT INC. AURORA, ILLINOIS

a leader in equipment for . . .

SEWAGE TREATMENT • WATER TREATMENT • INDUSTRIAL WASTE TREATMENT

NOW! FULL POWER IS 15 SECONDS FAST!



Solve peak-load and standby problems! F-M's exclusive O-P Diesel Generating Units provide *full* power in 15 short seconds . . . *from a cold start!* They need no spinning reserve. Use no power till you use them! The reason? Our exclusive O-P (Opposed-Piston) design. Two pistons in one cylinder function from a *single* combustion. This minimizes *vibration* . . . produces fine *balance, smooth* power to peak the generator—in just 15 seconds! F-M Opposed-Piston Diesel Generating Units are available with automatic or manual controls. Produce up to 2500 kw per unit. They may be linked in multiple units for peaking, standby duty . . . or dead load pickup! You can't buy better—or more economically.

For full details or custom specifications, write today to: **Mr. S. K. Howard; Diesel Division; Fairbanks, Morse & Co.; Beloit, Wisconsin.**

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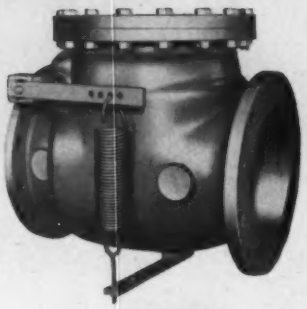
A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY

EDDY New Improved Products Meet Modern Needs

EDDY Fire Hydrant

- Improved, streamlined, modernized
- Optional break-flange
- Large diameter barrel
- New self-sealing main valve packing
- Requires no lubrication
- Opens *with* pressure
- Closes *against* pressure
- Underwriters' listed
- Standardized, interchangeable parts

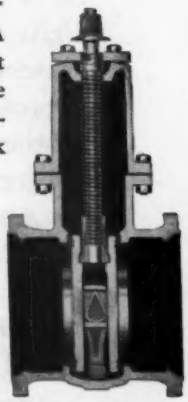


EDDY Check Valves

Completely new designs of horizontal swing check valves are available in sizes from 4 through 12 inches. They operate dependably in either vertical or horizontal positions and incorporate construction features which provide unusual flexibility of operation. These valves may be converted in the field from plain to single- or double-lever operation to meet changing requirements. Other check valves up to 24 inches.

EDDY Gate Valves

In addition to the regular line of EDDY Taper Seat AWWA gate valves, EDDY now offers a newly designed parallel seat AWWA gate valve in sizes through 12 inches. This valve has been specifically engineered to provide long, trouble-free service. Working parts are designed with heavy, thick section and large seating surfaces for dependable operation and improved wearing qualities. The valve has two-point, free-floating wedging for minimum friction and maximum operating ease. Other AWWA gate valves are available through 48 inches.



Whatever your waterworks requirements, it will pay you to have full information on the complete EDDY *line of valves and hydrants.*

EDDY VALVE COMPANY
A Subsidiary of James B. Clow & Sons, Inc.
WATERFORD NEW YORK

quickly installed in old piping!

MUELLER® copper meter yokes

NEW compression couplings

...for steel or copper pipe

...with or without locking nut

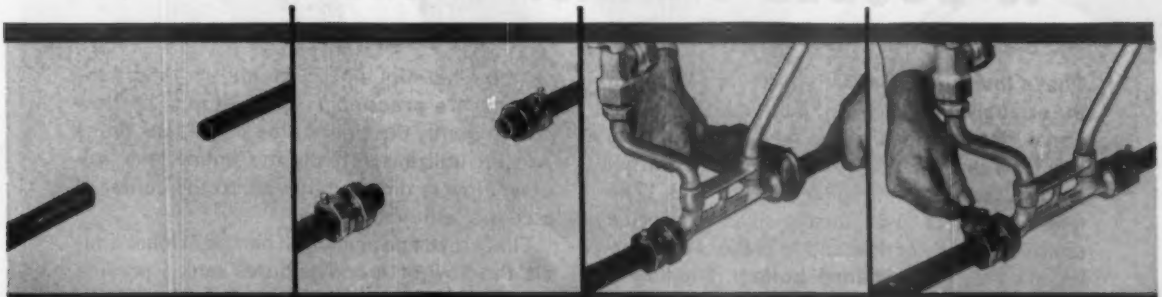
You can now install Mueller Copper Meter Yokes in any existing steel or copper piping in just a few minutes — and without cutting threads or sweating joints.

The simple step-by-step procedure for installing a yoke with Mueller's new Compression Couplings is shown below. Permanent, water-tight joints are quickly made even on rough and badly pitted pipe. Possible trouble is avoided because the piping does not have to be moved.

These new, time-saving couplings are now available for all Mueller Copper Meter Yokes with Multi-Purpose Ends. Regular compression nut or locking nut designs can be furnished for steel or copper pipe.

The locking nut type (shown) positively prevents any movement of the yoke on the pipe and insures continuous electrical bonding of the service piping.

Write for complete information and specifications on Mueller's Copper Meter Yokes.



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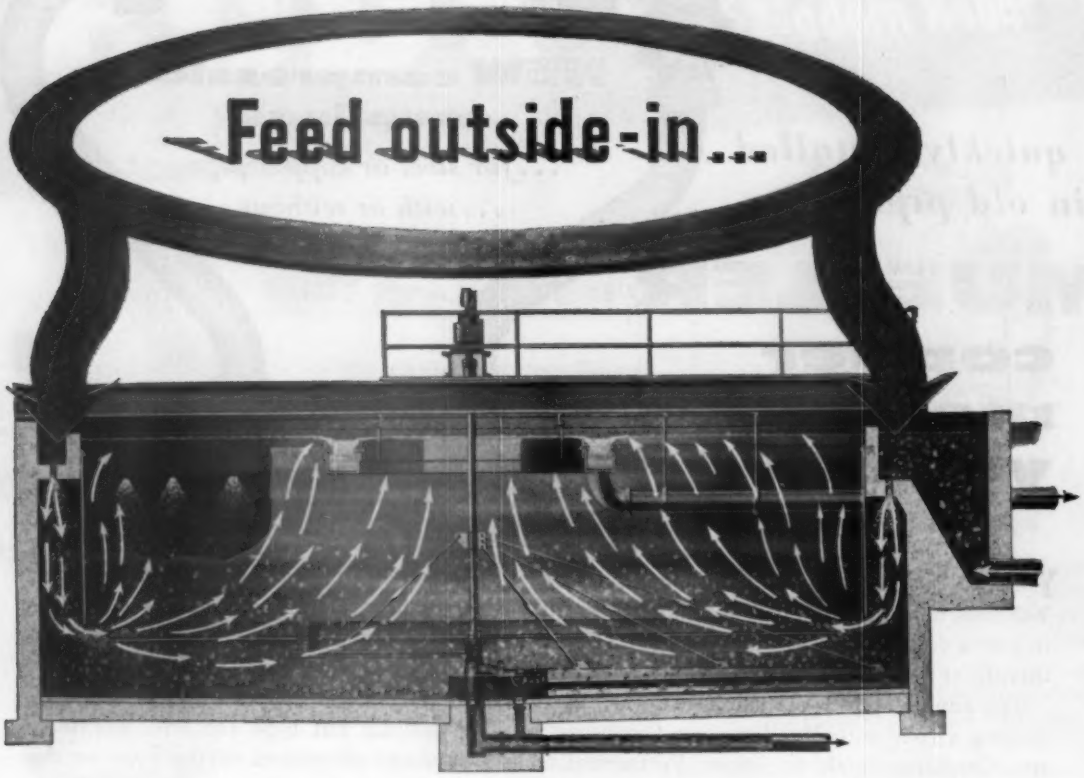

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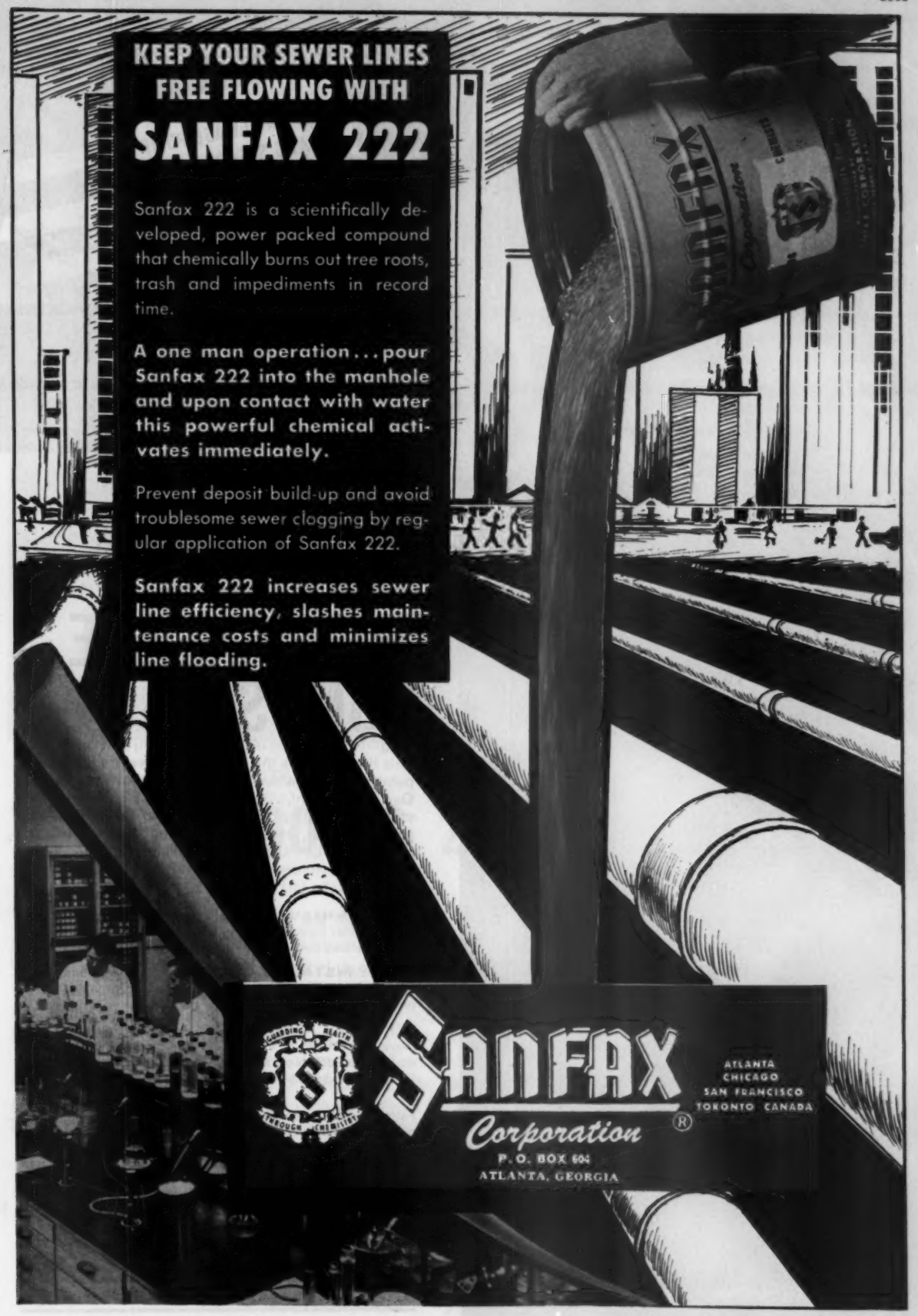
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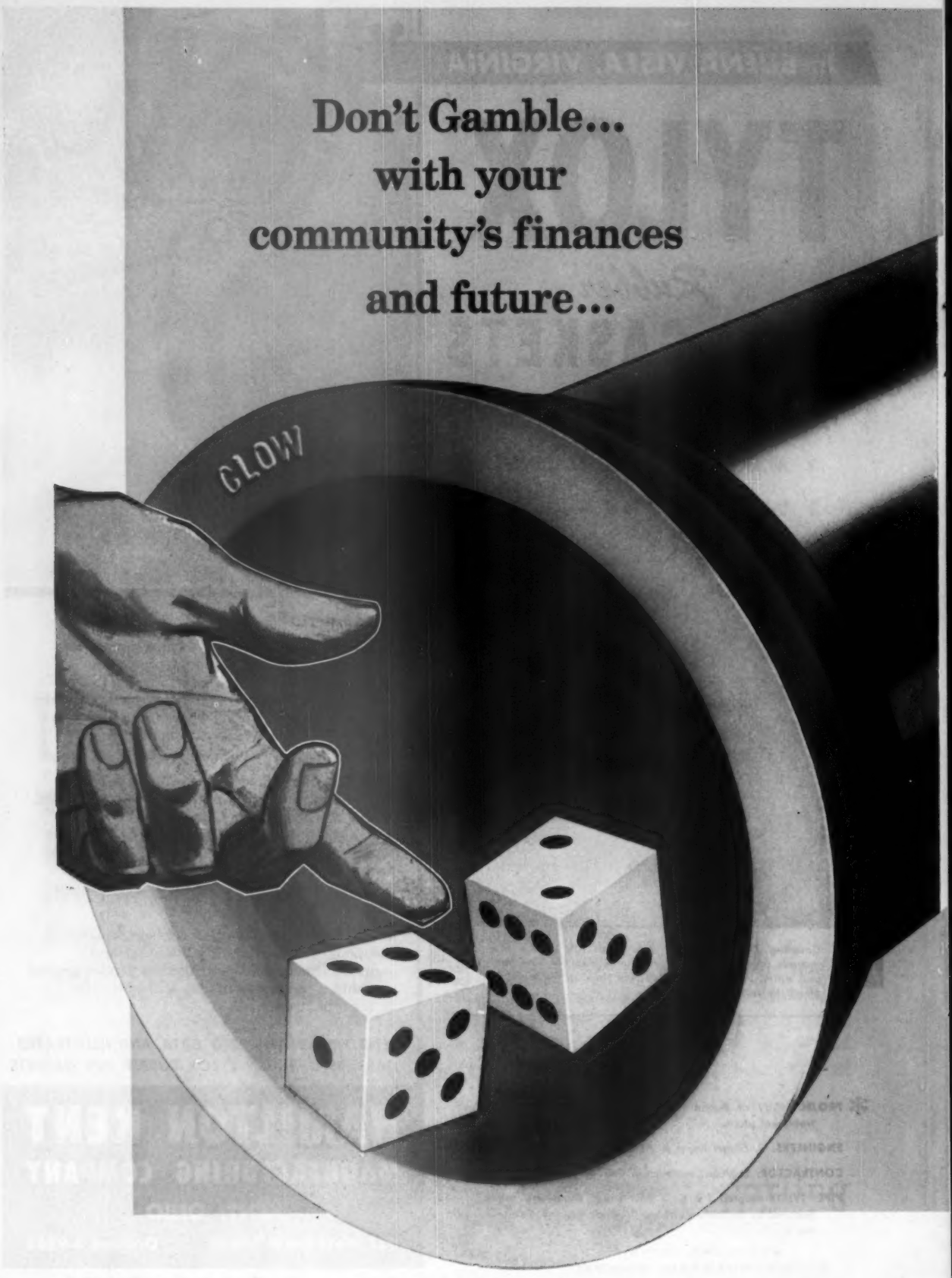
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Pollution - Urban Vs Rural in Imperial Valley Waters - Part 1

by HARVEY F. LUDWIG
ANDREW L. GRAM
JOSEPH L. FEENEY
Engineering-Science, Inc.
Arcadia, California

■ FOR MANY years Brawley's waste waters have been discharged untreated into the New River without creating any apparent nuisance. Recently, however, the question has arisen whether this practice is contributing to unhealthful conditions in the Salton Sea. The Regional (Colorado River Basin) Water Pollution Control Board of the State of California has taken the position that all sewage flows to the New and Alamo Rivers should receive treatment prior to discharge. The objective of this study, undertaken by Engineering-Science, Inc., on behalf of the City of Brawley, was to determine what steps should be taken by Brawley for the proper disposal of its sewage.

The New and Alamo Rivers are fed mostly by irrigation drainage originating in the Imperial Valley. Both streams contain little water at the Mexican border, but at their mouths in the Salton Sea the flow in each is of the magnitude of 500 to 1,000 cfs (cubic feet per second). Since the beginning of irrigation practice around 1900, the river flows have gradually increased to their present levels, and, being turbulent and silt-laden, have been able to receive untreated sewage discharges from various communities without the formation of nuisance conditions.

Since the time of its formation, the Salton Sea has been the scene of some recreational activity, but in recent years such activities as swimming, fishing, and water skiing have greatly expanded, primarily to serve the recreational needs of the expanding population of metropolitan Los Angeles. There is every indication that these recreational uses will continue to increase, thus changing the basic concept of the Salton Sea from an essentially single-purpose drainage basin to one of dual purposes in which public recreation will assume an increasingly important role.

For the most part, water contact sports have been confined to the eastern and western shores of the Sea. On the southern shore access is difficult and the water is shallow and turbid; however, a State beach extends from the north end of the Sea south along the east shoreline to Bombay Beach. The most active beach developments are located on the west shore, notably at Desert Shores and Salton Sea Beach. As shown in Figure 6, most of the southern end of the Sea is a National Wildlife Refuge, and a large section of the Sea and shoreline on the southwest is restricted by the Atomic Energy Commission.

Several studies have been made in the last ten years to investigate the extent and effects of pollution in the Salton Sea. The Regional Water Pollution Control Board, in cooperation with the U. S. Public Health Service, published a report in 1953 which described water pollution conditions within the region. In 1958-59 the California State Department of Public Health collaborated with several other public agencies on a bacteriological study of the Salton Sea and tributary waters[2]. Beginning in 1954 the California State Department of Fish and Game sponsored a research program with the Department of Zoology, University of California at Los Angeles, which was directed toward promoting the game fish population in the Salton Sea[3].

These various studies included limited programs for sampling and analysis of the water in the Sea, including determinations of levels of coliform bacteria as an index of sewage pollution. These analyses in general revealed that both the New and Alamo Rivers contained high concentrations of coliform bacteria, and that it was possible to detect these organisms in the Sea itself only within a radius of several miles from the river mouths. The specific sources of the bacteria were not completely determined, but both municipal sewage discharges and agricultural drainage were indicated. In the State Department of Public Health study (reference 2) a strip of the Sea extending along the southern shore, from about 2 miles west of the New River mouth to about 10 miles north of the Alamo River mouth, was indicated to be unsuitable for contact sports. The criterion of suitability was the State Department of Public Health's standard requirement for bathing beaches, namely that not more than 20 per cent of the water samples collected may show coliform concentrations in excess of 10 per milliliter.

In 1955 the Regional Water Pollution Control Board set general requirements for the disposal of wastes into the waters of its region.[4] While recognizing that the principal use of the Salton Sea has been a disposal sump for agricultural drainage, and that the rivers served primarily as drainage canals, the Board stated "it is not in the public interest to permit the uncontrolled discharge of any domestic or industrial wastes into the waters of the State". Among the stated requirements was the stipulation that no untreated sewage should be discharged to any of the receiving waters, and that in the New River below Lyons Crossing the dissolved oxygen concentration should not be less than 5.0 ppm and the BOD not greater than 5.0 ppm at any point more than one-quarter mile downstream from a waste discharge. In the Alamo River between the Alamo River Spillway of the All American Canal and North End Dam, the dissolved oxygen was required to remain above 4.0 ppm and the BOD to remain below 6.0 ppm.

The City of Brawley, along with Mexicali, Calexico, Westmorland, and other minor communities, discharges sewage wastes to the New River. One deterrent to the initiation of active anti-pollution measures by communities along the New River has been the fact that Mexicali, with a population greater than that of the entire Imperial Valley, has been discharging all of its sewage untreated to the river. Recently plans were announced for the construction of a treatment plant at Mexicali, to be completed reportedly in 1961. Such a plant would of course significantly reduce that portion of New River pollution which is due to wastes of human origin.

The position of the City of Brawley has been one of being interested in constructing whatever facilities are really needed for treating its sewage for the purpose of providing proper protection to the receiving waters. The problem has been to define the real needs. Discharge of raw sewage for many years has not resulted in any known or proven damages to proper beneficial uses of the receiving waters, and over the years the population and economy of the Imperial Valley have not materially changed and hence have not created any significantly new set of beneficial use conditions. The growing recreational use of the Salton Sea is, however, changing the general picture and it is this development which has focused current attention on the adequacies and/or inadequacies of the municipal sewage disposal systems operated by the Imperial Valley communities. The purpose of this study was to review all available information bearing on Brawley's situation, and to develop from these data whatever conclusions can be made as to the effects of Brawley's sewage discharges on the receiving waters and as to the proper treatment measures which the City should undertake.

Scope of Study

The engineering work involved in the study comprised the following elements:

(1) A critical evaluation of Brawley's sewage disposal needs with respect to pollution problems in the New River and in the Salton Sea, including a review of all available information related to pollution of those waters, delineation of the various sources of pollution, and estimation of their pollutional effects.

(2) An analysis of the general measures which should be taken by communities discharging wastes to the New River in order to bring about significant reductions in existing pollution problems in the river and in the Salton Sea.

(3) Preparation of recommendations for action, both immediate and long-range, by the City of Brawley.

The primary source materials used in the study are given in the List of References. In addition to the published reports, data was obtained from the State Department of Water Resources, the Imperial Irrigation District, the Imperial County Health Department and the Imperial County Assessor, and from officials of the City of Brawley.

Indices of Pollution

The extent of pollution in any receiving water is conventionally measured in several ways, the most common criteria being the dissolved oxygen, biochemical oxygen demand, and coliform bacteria concentrations. Of particular significance in this study is the density of bacteria of the "coliform group". This is the index conventionally used by health departments in the United States to indicate the safety of water for human exposure. Although coliform bacteria themselves are not disease organisms, they are present in large numbers in human and animal feces and hence their presence in water is indicative of possible or probable fecal contamination. As previously noted, the State Department of Public Health has established a standard for bathing waters such that not more than 20 percent of the water samples collected may show more than 10 coliform organisms per milliliter. This is considered to indicate the level of bacterial contamination above which bathing waters are considered as risky for human exposure.

The coliform concentration of a bathing water is usually expressed as the "MPN" or most probable number of organisms present, per milliliter. The result of a single coliform analysis is not particularly meaningful, in that this one test result may deviate considerably from the average; however, the results of a large number of tests are significant and when expressed statistically as the MPN do indicate the average level or concentration of organisms. The results of a number of samples at a sampling station are commonly expressed in terms of that concentration of coliforms which is exceeded by 20 per cent of the samples, since this is considered a more significant index for sanitation purposes than the average for all the samples.

Coliform organisms discharged to a stream, like other organic matter, are subjected to the natural treatment processes going on in the stream and in this unfavorable environment tend to be destroyed and eliminated. This natural die-off is primarily a matter of time, the longer the exposure the greater the reduction of coliforms.

Unfortunately, despite the fact that the coliform concentration is the conventional index used by State health departments throughout the United States for evaluating pollution in receiving waters, the coliform group of bacteria contains, in addition to fecal organisms, other organisms not of sanitary significance. Among these other organisms is the aerogenes group of bacteria which are commonly found in soil washings. Accordingly, in situations where agricultural sources may be involved as well as human sources, the coliform test in itself is not necessarily indicative of sewage contamination. In such instances it is necessary to consider, together with the coliform tests, all other types of information, such as from field inspections, which may bear on the situation before arriving at conclusions as the probable extent of pollution.

A recent paper by Max Levine and his associates points up the need for a more specific bacterial index of pollution. As noted by Levine, the coliform group, as now employed, is considered to fall far short of an ideal index of sewage pollution for beaches and other bathing waters. Since coliform organisms are widely distributed in nature, their presence in bathing waters may merely be indicative of contamination with soil washings, and a correlation between coliform indices in such waters and incidence of intestinal or other diseases among bathers has not, as yet, been substantiated. It is

probable that a better correlation could be demonstrated if a specific fecal organism, such as *E. coli*, were employed as the index. Accordingly Levine has developed methods by which *E. coli* and coliform indices may be determined simultaneously and suggests, pending further research, that the simultaneous determination of *E. coli* and of coliforms would shed considerable light on the value and significance of the coliform determination. If the pollution in a receiving water were due to sewage or animal wastes, the incidence of *E. coli* would by many times that of the other members of the coliform group whereas, in comtamination by soil washings, *E. coli* would make up only a very small portion of the total coliform count.

Regional Water Pollution Control Board Criteria

The Regional Board, in establishing requirements for waste discharges in the Imperial Valley, generally has used coliform, BOD, and dissolved oxygen concentrations as the primary criteria, applied both to receiving waters and to the waste discharges themselves. The Board has also generally specified that there be no visible grease, oil slicks, or solids recognizably of sewage origin.

Sources of Pollution

The sources of the BOD and coliform organisms in the rivers and Sea are cities, cultivated fields, and a number of miscellaneous dischargers, such as stock feed yards, industries, farm labor camps, and isolated farms and institutions. Available information on the amounts of BOD derived from these sources are summarized in Table I.

Sewage Discharge to New River

Municipalities which discharge sewage to the New River are Mexicali, Calexico, Brawley, and Westmorland. Mexicali has an estimated population of some 125,000, or about twice that of the entire Imperial Valley. Only a portion of the population is connected to the sewer system; in 1954 it was estimated (Reference 1) that 19,000 of the then 65,000 population were connected. Applying the same percentage to the present population gives an estimated connected population of 37,000. Calexico has about 9,000 population, and Brawley about 14,000. No treatment is given to any of the sewage from Mexicali, Calexico, or Brawley before discharge to the river. Westmorland has a population of about 1,500, but only about half is served by sewers, and a sewage treatment plant consisting of an Imhoff tank reduces the BOD of the sewage by about 30 per cent.

The Pioneer Memorial Hospital south of Brawley has a sewage treatment plant, but its rate of BOD production is quite small. The El Centro Naval Air Station at Seeley now has a population of about 600; however, the base is in the process of being deactivated and the number of personnel is constantly being reduced. Moreover, the sewage from the base discharges into an oxbow of the New River, which serves as an effective oxidation pond and hence provides fairly complete treatment. Conventional oxidation ponds, designed for 1,200 population, are now under construction and will be put into operation in the near future.

The average population of Mexican nationals living in farm labor camps in the Imperial Valley is estimated at 13,000, of which only about 3,500 are believed to be located outside of towns or cities. Since about 30 per cent of the irrigated land in the Imperial Valley lies in the New River watershed, it may be assumed that this percentage of the rural labor camp population is tributary to the New River. Sewage treatment consisting of septic tanks or oxidation ponds is required for all camps, although there may be a few older ones still discharging raw sewage. The average reduction in BOD can be considered as at least 50 per cent.

There are about 100 cattle feed yards in the Imperial Valley. It is not believed that they are a significant source of stream pollution. Practically all of the animal wastes are collected and used as fertilizer, and no washing down is normally practiced whereby organic materials could regularly be carried into the drainage system. During heavy rain-

Table I
Sources of Pollution
(Not Including Agricultural Drainage, Feed Yard Drainage, or Natural Sources of Pollution)

Source	Nature of Pollution	Population	Sewered Population	Estimated BOD Produced lb/day	Estimated BOD Discharged lb/day	Estimated Average Flow mgd
New River						
Mexicali	Sewage	125,000	40,000	6,800	6,800	4.0
Calexico	Sewage	9,000	9,000	1,500	1,500	0.9
Brawley	Sewage	14,000	14,000	2,400	2,400	1.7
Westmorland	Sewage	1,500	800	100	70	0.1
Pioneer Hospital	Sewage	—	—	70	20	—
El Centro NAS	Sewage	600	600	100	50	0.1
Farm Labor Camps	Sewage	1,200	600	100	50	—
Streamside Feed Yards	Manure	—	—	70	70	0
Rural Sewage	Sewage	3,000	—	500	250	—
Total				11,640	11,210	
Alamo River						
Holtville	Sewage	3,800	3,800	650	200	1.2
El Centro[1]	Sew. & Ind. Waste	19,000	19,000	5,000	250	2.0
Imperial	Sewage	2,000	2,000	340	70	0.2
Calipatria	Sewage	3,000	3,000	510	510	0.2
Holly Sugar	Sugar Waste	—	—	7,500	2,500	1.6
Farm Labor Camps	Sewage	2,400	1,200	200	100	0.2
Rural Sewage	Sewage	600	—	1,000	500	—
Total				15,200	4,130	
Other						
Niland	Sewage	500	500	80	50	—
Rural Sewage	Sewage	1,000	—	200	100	—
Total				280	150	
Total Valley Sources				27,120	15,490	

[1]Discharged untreated sewage to New River until Fall 1958.

fall the run-off from feed lots probably carries some pollutional load, but rainfall is not common in the area. At several points along the New River there are feed yards located on the river banks, in which the cattle have direct access to the stream. The BOD contribution from these particular yards is estimated at about 70 lb/day.

As shown on Table I, the principal sources of sewage pollution in the New River are the cities. Mexicali is by far the greatest contributor, but Brawley and Calexico also discharge significant amounts of BOD. The other sources mentioned contribute minor amounts of pollution.

Sewage Discharge to Alamo River

The cities of Holtville, El Centro, Imperial, and Calipatria all dispose of their sewage into the Alamo River. Holtville has a treatment plant consisting of an Imhoff tank and low-rate trickling filter which gives about 75 per cent removal of BOD. Imperial has about 2,000 population; its sewage treatment facilities, consisting of primary settling tanks and oxidation ponds, effect a BOD reduction of more than 80 per cent. Calipatria, with about 3,000 population, discharges its sewage untreated.

El Centro, which has a population of some 19,000, formerly pumped its sewage untreated to the New River, but in 1958 a new treatment plant was put into operation, consisting of primary sedimentation tanks followed by oxidation ponds. The effluent is discharged into the Central Drain System, which flows to the Alamo River. The strength of the El Centro sewage has been rather high because of industrial waste components, notably whey discharges from a creamery, but the plant provides more than 90 per cent removal of BOD. Also, steps have recently been taken to exclude the whey from the sewerage system.

The Holly sugar refinery, located between Brawley and Imperial, operates about three months per year (from May to July), and during that period produces a high-strength liquid waste. It is treated by primary clarification followed by 70 acres of oxidation ponds. The effluent BOD averages about 200 ppm, and the flow averages about 1.6 mgd during the season of operation. Effluent reaches the river through the Rose Drain System.

As in the New River, farm labor camps probably contribute a certain amount of pollution, which is estimated at about 100 lb BOD/day. In addition to the pollutional load carried by the New and Alamo Rivers, the southern end of the Salton Sea also receives settled sewage from the Niland Sanitary District. This waste from a population of about 500 flows into the "R" Drain and reaches the Sea two miles northeast of the Alamo River mouth.

Table I shows that the principal known source of organic pollution in the Alamo River is the Holly sugar refinery. Since the Holly waste is completely industrial, it cannot be considered a hazard to public health, nor is it a source of coliform bacteria. All other sewage pollution contributions are small and the total sewage organic loading discharged to the Alamo is a small fraction of that discharged to the New River.

Sewage Discharge to Agricultural Drains

In the central Imperial Valley there are over 600,000 acres under irrigation. Nearly all of the crop land is underlain by tile drains which remove excess irrigation water with its burden of salt. A net work of ditches receives the field drainage and carries it to either of the two rivers or directly to the Salton Sea. The Imperial Irrigation District, the sole supplier of water in the Valley, operates over 1,300 miles of main and lateral drains.

Several of the sources of sewage pollution mentioned previously discharge into drains rather than into the rivers directly. The sewage from farm labor camps and that from isolated farms generally reach the drainage system; even effluents from septic tanks passed into leaching fields, after percolating through some distance of soil ,may eventually arrive at a drain. The Imperial Irrigation District permits the use of its drains for removing all waste flows, provided there is no resulting damage to agriculture, but the Regional Water Pollution Control Board sets requirements on all such discharges of any importance. For such discharges an oxidation pond, or a septic tank with a leaching field, generally must be provided.

The quantity of sewage pollution represented by isolated rural discharges is unknown and cannot be directly determined from presently available data. Septic tanks with underground outlets would not be important contributors; the passage of sewage through soil effectively oxidizes all sewage organic materials including bacteria. Oxidation ponds can be relied upon for BOD reductions of 80 per cent or more, so that their effluents cannot be considered significant. The estimated population tributary to the southern part of the Salton Sea which has not already been taken into account probably does not exceed 10,000. These people are widely distributed geographically, and their total BOD production is about 1,200 lb/day. Since most of the farm sewage is treated (if only by a septic tank), and considerable natural purification must take place during its passage through the agricultural drainage system, the river pollution load is probably not significantly increased by these discharges.

Other Sources of Pollution

As discussed later, the discharges from agricultural drains contain high concentrations of coliform organisms, and are probably important sources of BOD as well.

Sea Water Conversion Plant

This view of new 1,000,000 gallon per day facility at Freeport, Texas shows seven of 12 large evaporators, key units in production of fresh water from the sea. Built by Chicago Bridge & Iron Company

for the Interior Department's Office of Saline Water, the plant is the federal government's first sea water conversion demonstration plant. Cost of water produced by the Freeport plant will be less than $1 per thousand gallons. The new facility successfully completed its eight-day design production test on May 31.

RESEARCH PROGRESS REPORT

An Improved, Short-Term, BOD Test

by A. W. BUSCH, Asst. Prof., Dept. of Civil Engineering Rice University Houston, Texas

■ TO EVALUATE THE EFFECTIVENESS of treatment processes and to avoid the creation of nuisance conditions in streams by discharge of excessive amounts of putrescible substances, some broadly applicable measure of the "strength" of organic wastes is necessary. The most important single characteristic from the standpoint of water pollution control and waste treatment is the amount of oxygen required for biological stabilization. This value, termed *Biochemical Oxygen Demand* and commonly spoken of as *BOD,* is determined as a standard procedure by incubating appropriate samples for five days at 20° Centigrade and establishing the amount of oxygen utilized in various dilutions. The oxygen utilization is due to the aerobic action of micro-organisms, principally bacteria and protozoa, feeding upon the organic constituents of the waste. Valid results from such a test are obviously dependent upon the presence in the incubated sample of organisms which are able to attack and break down the organic compounds. The presence of such organisms is insured by seeding the diluted sample with micro-organisms prior to incubation.

Some fifty years ago when domestic sewage was the only wastewater of significance, investigators discovered that the day-to-day progression of BOD in an incubated sample in many instances conformed closely to the graphic path of a first-order reaction equation.

A plot of experimental data with BOD exerted as the ordinate versus time as the abscissa shows, for sewage, a curve which can be expressed mathematically by an exponential function formulation. Figure 1 shows an idealized BOD curve for a "normal" domestic sewage. Expressing the reaction in words: the rate of biochemical oxidation or organic matter is proportional to the remaining concentration of oxidizable material. This proposition is based on the assumption that the amount of available oxygen is not limiting. A first-order equation implies a constant rate of reaction; in other words, a constant percentage of the remaining material is oxidized, or consumed, daily. For many years it was a widely accepted belief that the rate constant, or "k" value, of domestic sewage was essentially stable at a value of 0.1 for common logarithms, corresponding to a stabilization rate of 21 per cent of the remaining food per day. As evidence accumulated, it became apparent that the rate constant did vary from test to test. Since variations in "k" are most significant during the early portion of the incubation period, and were attributed largely to initial differences in the microbial seed population, the use of the 5-day incubation as the standard procedure became more entrenched. It was felt that by five days' time the variations in microbiological activity would be minimized and that consistent results would be attainable. Figure 2 shows how widely varying velocity constants can yield identical 5-day results.

It is pertinent to point out here that the concept of a first-order reaction occurring in an environment occupied by a heterogeneous microbial population feeding on organic material of widely varying composition and form is at variance with all established knowledge related to microbial metabolism. A number of investigators have commented on this anomaly, including the man who first formulated the equation. However, experimental data repeatedly verified the correlation for domestic sewage, and certainly the concept of a rate constant is extremely useful in forecasting the effect of a waste on downstream conditions. While the 5-day BOD value may be adequate for comparing wastes on a relative basis or for evaluating the effectiveness of a treatment plant, the characteristic of importance in water pollution control is the total load on the stream or the so-called ultimate BOD. For practical purposes this is usually considered to be the 20-day BOD. Figure 3 contains the data of Figure 2 plotted to a different scale and extrapolated to the 20-day value. The fallacy of a given waste being oxidized at different rates and yet producing a fixed 5-day BOD value

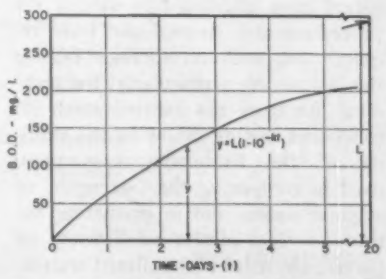


Fig. 1. IDEALIZED First-Order BOD Curve with k=0.1, and L=293.

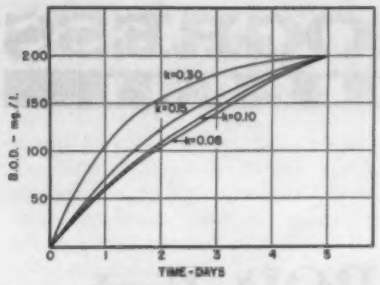


Fig. 2. FIVE-DAY BOD curves with various velocity constants.

is clear since logically a given waste must have a reproducible ultimate BOD. Following this line of reasoning leads to the presentation in Figure 4 showing that the 5-day BOD must vary with the rate constant since a fixed amount of oxidizable organic matter is present. It should be re-emphasized here that the whole concept of a valid 5-day BOD test is predicated upon the 5-day value representing a constant percentage of the ultimate oxygen demand.

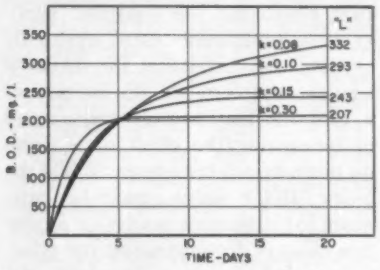


Fig. 3. EFFECT OF VELOCITY constant k on 20-day BOD L with fixed 5-day BOD. (After C.N. Sawyer, 1951)

Obviously a test requiring five days of incubation prior to analysis of samples has definite limitations. In other words, samples of a plant effluent taken on Monday cannot be analyzed until Saturday. By that time, the sampled effluent is well downstream. Many workers during the forty years since the test was established have attempted to modify the procedure and shorten the time required but with no success. During the last decade particularly, the technical literature has carried much information casting doubt on the validity of the first-order assumption used in comparing the "strength" of organic wastes and in predicting the rate of biological stabilization of putrescible matter in polluted waters. A high percentage of these papers were concerned with industrial wastes, particularly those containing predominantly dissolved organics.

Basis of Study[1,2,3]

In the fall of 1957, a project having as its objectives the detailed delineation of the actual progression of oxygen utilization in soluble organic substrates and the establishment of a valid short-term BOD test for such substrates was initiated at Rice University. The basis for the investigation was experimental data published by the writer in 1952[4]. It was mentioned previously that the 5-day BOD value was established as the standard yardstick since shorter incubation times were considered unreliable due to initial variations in microbial activity. Table I shows daily BOD values obtained in work involving a highly reproducible soluble substrate. These data, comprising some 660 individual analyses, show that the 1-day BOD values were by far the most reliable parameter. The daily increase in the coefficient of variation is of particular interest. It is also noted that the rate constant "k" calculated from the experimental data showed a variation of 44 percent, while the experimentally determined ultimate BOD values ranged from 133 to 279 mg/l. The only variable in this work was the seed population used in successive experiments. Figure 5 shows graphically the progressively increasing range of daily BOD values.

Theory of BOD Progression

On the basis of these and subsequent experiments, a theory was propounded which ascribed the progressive variation in BOD values to

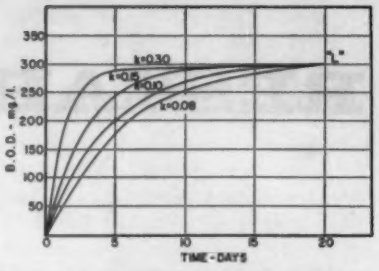


Fig. 4. EFFECT OF VELOCITY constant k on 5-day BOD with fixed 20-day BOD L. (After C.N. Sawyer, 1951)

the effect of varying ratios of bacteria to higher organisms in the seed population. In other words, soluble compounds are readily available to the bacteria and are quickly consumed,

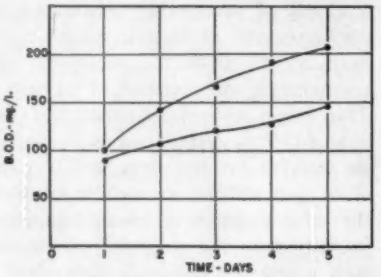


Fig. 5. RANGE OF DAILY BOD values for a synthetic sewage.

probably within 24 hours. Subsequent utilization of oxygen in excess of the respiratory requirements of the bacteria was attributed to the activity of higher organisms feeding on the bacteria. According to this theory, the higher the initial ratio of predator organisms to bacteria in the seed, the higher the 5-day BOD value. That this is a valid proposition was demonstrated experimentally

Table I

BOD Data for a Synthetic Sewage

EXP. NO.	Daily BOD Values 1	2	3	4	5	"K"	"L"
1	95	116	157	190	190	0.161	234
2	94	107	157	186	194	0.109	279
3	99	142	167	182	187	0.310	193
4	90	120	164	178	185	0.218	206
5	92	140	162	162	182	0.313	178
6	97	115	129	146	164	0.304	160
7	96	107	121	152	158	0.187	180
8	92	110	123	128	147	0.539	133
9	100	125	164	188	208	0.184	236
10	98	128	156	192	195	0.179	230
11	96	125	164	182	197	0.209	216
$Cv = \frac{\sigma}{M}$	0.03	0.09	0.11	0.12	0.10	0.44	0.18

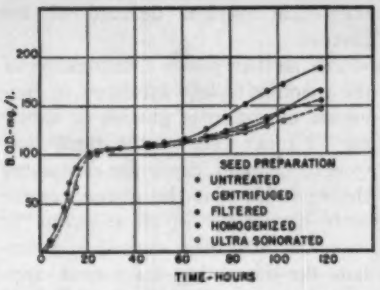


Fig. 6. BOD CURVES for a synthetic sewage direct method.

as shown in Figure 6. All samples agreed through 60 hours and, following initiation of predator activity, the sample containing the seed which

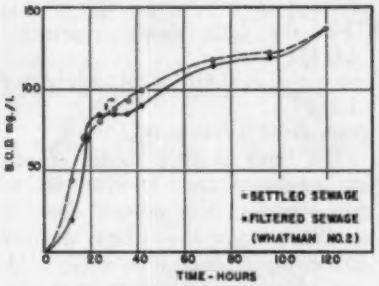


Fig. 7. EFFECT OF FILTERING on the progression of BOD of sewage.

had not been altered physically yielded the highest 5-day BOD value. As a further demonstration of the effect of predator organisms, filtered

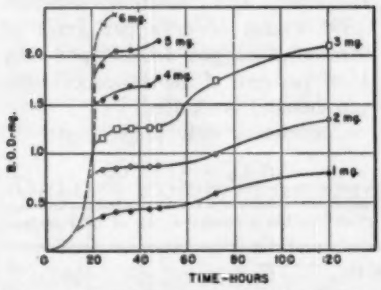


Fig. 8. PROGRESSION OF BOD for various glutamic acid concentrations.

and unfiltered samples of domestic sewage which had been settled to remove suspended matter were used to determine the BOD progression. Figure 7 shows clearly how the typical first-order curve noted so often for domestic sewage can be altered by disturbing the bacteria-predator balance. It is interesting to note that the 5-day BOD values are identical.

Reproducibility of Plateau

Having established that the progression of BOD in soluble substrates is a two-stage and not a first-order reaction, efforts were concentrated on determining whether the plateau representing conversion of food into bacterial cells was reproducible for a given compound. A correlation between plateau oxygen demand values and theoretical BOD was established for several pure compounds. Figures 8 and 9 show the results of a typical experiment.

Use of Plateau

With the establishment of the validity of the first-stage plateau as a reproducible percentage of the theoretical BOD, a study was initiated to determine the possibility of increasing this percentage by selective poisoning of the bacterial assimilatory processes using the technique developed by Clifton[5]. The result of blocking assimilation would be an increased respiration and thus a higher ratio of plateau values to theoretical BOD. The relation between respiration and assimilation is presented diagrammatically in Figure 10.

In the investigation, both manometric and bottle dilution techniques were employed for the determination of BOD values. The manometric

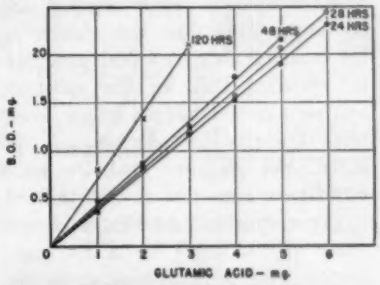


Fig. 9. BOD vs. glutamic acid.

procedure requires the use of relatively high concentrations of both substrate and seeding organisms. Therefore, these experimental conditions are directly related to the concentration of substances normally found in waste water treatment plants but are markedly higher than those encountered in pollution studies of streams. This procedure was used to study the broad aspects of the problem where it was not feasible to prepare large numbers of bottle samples. Bottle determinations were used to confirm the results of the manometric method in dilutions applicable to stream conditions. It is seen that the techniques employed encompass the broad realm of biological oxidation, from waste treatment plant design to pollution control studies.

Typical results are shown in Figures 11 through 15. The sensitivity of the phenomenon of respiration stimulation is especially apparent in Figure 13. Although substantial increases in plateau values were obtained for glucose, glutamic acid, and a 1:1 mixture of these, in combination with sodium azide, the lag induced by partial inhibition of respiration offsets any particular advantage of its use in a short-term BOD test. Other inhibitory agents studied showed no significant effects.

Cell Production Characteristics at the Plateau

The next phase of the study was initiated on the postulation that there is no essential difference in the progression of bacterial growth over the broad range of environments encountered in industrial waste treatment and water pollution control. There should be basic parameters relating the areas of pollution measurement, waste "strength", biological treatment and receiving water self-purification. Investigators have generally approached these problems as

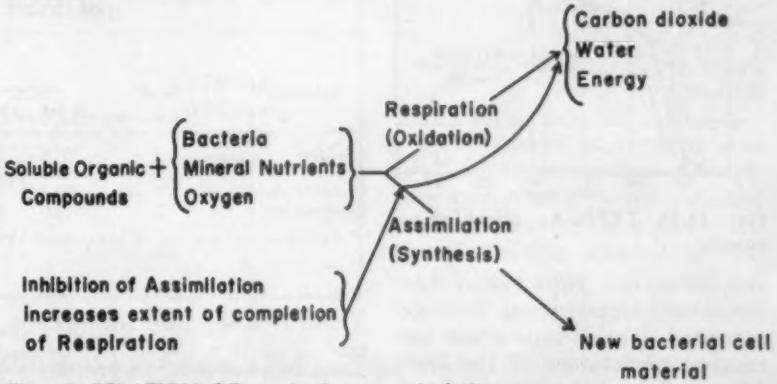
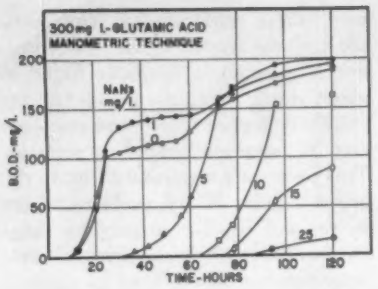
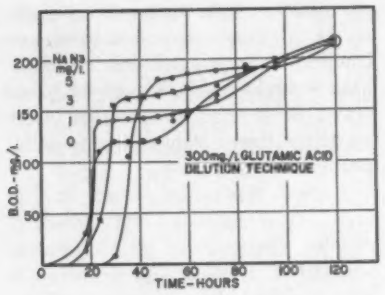
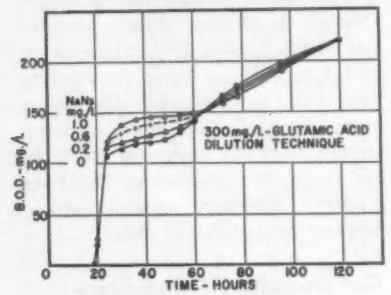
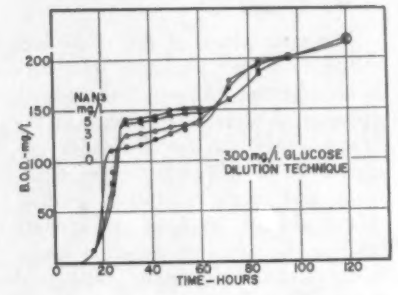


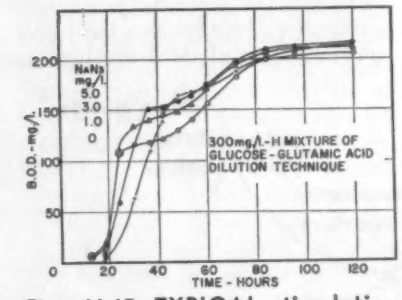
Fig. 10. RELATION OF respiration to assimilation.











Figs. 11-15. TYPICAL stimulation curves.

separate entities. There follows theoretical and experimental evidence, supported by mathematical and biochemical formulations, of the interrelation of these areas of study.

The reproducibility of the plateau in oxygen utilization for a particular substrate has been mentioned previously. Workers in the field of microbiology have reported similar results in pure culture studies. In addition, investigators studying activated sludge have commented on the reproducibility of cell production under controlled experimentation. It follows logically that, since the plateau in oxygen utilization in the BOD bottle represents conversion of substrate into cells, there should be a correlation between short-term BOD and bio-oxidation solids production under conditions of similar solids age. Such a correlation, based on biochemical reactions, presupposes a permissible general formulation for cell material.

Statistical Reliability of Plateau

A statistical analysis was made of the short-term BOD test values for the two primary 5-day standards. (See Table II). Seed from two sources was utilized with each substrate. Each statistical analysis was based on twelve replicate runs using three substrate dilutions. Hence, N has a value of 36. The short-term BOD incubation period selected was 36 hours. This time was chosen on the basis of data, reported previously[1] showing that for the substrate and seed concentrations in use, complete linearity for glucose was assured. For glutamic acid, 24 hours could have been just as well utilized.

These data indicate that a plateau value of 132 mg/l for a 300 mg/l glucose solution is quite reproducible. This represents 41.1 per cent of the theoretical oxygen demand of the glucose.

The next step was a delineation of the mode of solids synthesis in biological oxidation of glucose in exerting 41.1 per cent of the theoretical oxygen demand. Since the postulated theory holds that the plateau represents conversion of all substrate to bacterial cells, these cells should contain the remaining theoretical oxygen demand. Porges, *et al.*,[6] have suggested a general formula of $C_5H_7NO_2$ for mass mixed cultures. The general reaction can be written as:

$$A \cdot C_6H_{12}O_6 + B \cdot O_2 \rightarrow X \cdot C_5H_7NO_2 + Y \cdot CO_2 + Z \cdot H_2O \quad (1)$$

Thus the cells should represent: $\frac{1-0.411}{1.414^*} = 0.416$ g of solids per gram of BOD removed.

The three possible modes of solids synthesis are: 1. synthesis of cells directly; i.e., growth only, 2. oxidative conversion into another carbohydrate, respiration only, or 3. a combination of growth and respiration.

Synthesis alone can be considered as:

$$C_6H_{12}O_6 + O_2 + NH_3 \rightarrow C_5H_7NO_2 + CO_2 + 4H_2O \quad (2)$$

However, this reaction indicates 0.591 grams of cells per gram of theoretical oxygen demand and only 16.67 per cent of the theoretical oxygen demand is exerted.

Considering only respiration:

$$C_6H_{12}O_6 + (1-5)\ O_2 \rightarrow (5-1)CH_2O + (1-5)CO_2 + (1-5)H_2O \quad (3)$$

*$C_5H_7NO_2$ has a theoretical OD of 1.414 gm/gm.

Table II

Statistical Analysis* of Reproducibility of Short Term BOD

Substrate**	Seed+	BOD 36 HR	BOD 120 HR	σ 36 HR	σ 120 HR	$\frac{\sigma}{M}$ — % 36 HR	$\frac{\sigma}{M}$ — % 120 HR
Glucose	1	131.8	221.5	2.61	1.84	1.98	0.80
Glucose	2	132.0	220.6	2.09	2.67	1.58	1.21
Glutamic Acid	1	123.7	217.8	2.57	2.03	2.08	0.93
Glutamic Acid	2	123.0	217.8	2.37	2.05	1.93	0.94

* Each analysis based on 12 experiments of 3 dilutions each, i.e., N = 36

** All 300 mg/l.

+ Seed 1—West University Place, Texas, Sewage, 5 ml/l., Filtered
Seed 2—Bellaire, Texas, Sewage, 5 ml/l., Filtered

Dilutions used: 5, 7, 9 ml 300 mg/l Solution per bottle
Substrate Concentrations: 1.50, 2.10 and 2.70 mg/Bottle; 4.84, 6.77 and 8.71 mg/l.

Table III

Correlation of Short-Term BOD and Solids Production in Glucose Oxidation*

Glucose Concentration: 500 mg/l, Warburg Technique
Sample Volume: 40 ml.
500 mg/l x 40 ml = 20 mg Glucose = 21.4 mg Theor. OD

Maximum Solids Production: (at max Carbohydrate)
Predicted: 21.4 mg x 0.49 = 10.49 mg.
Observed*: 265 mg/l x 0.04L = 10.60 mg.

Solids Production at Maximum Protein level:
Predicted: 21.4 mg x 0.42 = 9.0 mg.
Observed*: 164 mg/l x 0.04L = 9.0 mg.
*Using data of Gaudy and Engelbrecht[10]

In this reaction solids production and oxygen utilization can proceed only in increments of 16.67 per cent which is not a multiple of 41.

Writing the reaction for a combination of respiration and growth:

$$8C_6H_{12}O_6 + 18O_2 + 4NH_3 \rightarrow 10CH_2O + 4C_5H_7NO_2 + 18CO_2 + 30H_2O \quad (4)$$

The reaction is governed by the respiratory quotient of glucose which has a value of 1. The equation shows:
0.195 gram of CH_2O produced per gram of theoretical oxygen demand removed,
0.293 gram of $C_5H_7NO_2$ produced per gram of theoretical oxygen demand removed,
0.488 gram of solids produced per gram of theoretical oxygen demand removed,
and 0.4 gram or 37.5 per cent of the theoretical oxygen demand is exerted.

At this point the substrate has obviously been consumed insofar as soluble BOD is concerned. However, as the stored carbohydrate is oxidized to cells,

$$6CH_2O + O_2 + NH_3 \rightarrow C_5H_7NO_2 + CO_2 + H_2O \quad (5)$$

an additional 0.122 gram of cells is produced which plus the 0.293 gram of cells first synthesized yields a total of 0.415 gram of cells as predicted by the short-term BOD experimental data. Furthermore, an additional 0.037 gram of BOD is exerted which yields a total of 0.437 gram or 41.0 per cent of the theoretical oxygen demand which is the plateau value of the glucose BOD progression. These equations represent a significant breakthrough in the research program.

Solids Production vs. Solids Age

A number of workers have formulated the mathematical expression

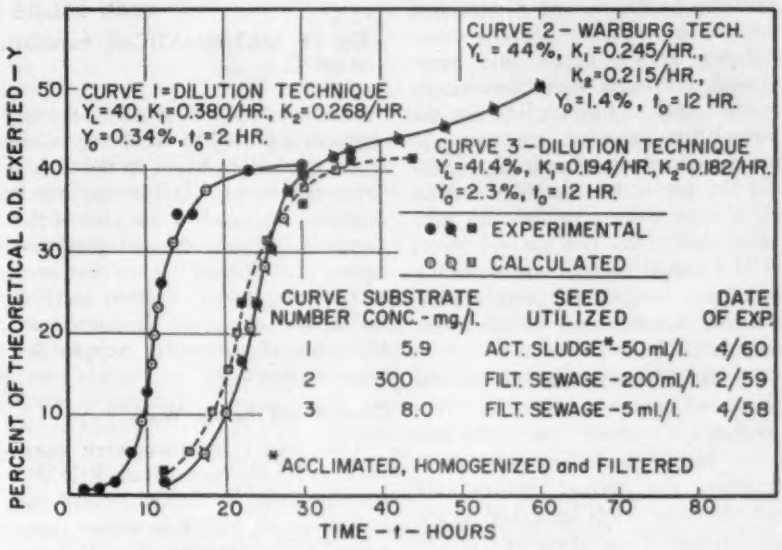


Fig. 16. BOD PROGRESSION curves for glucose at 20°C.

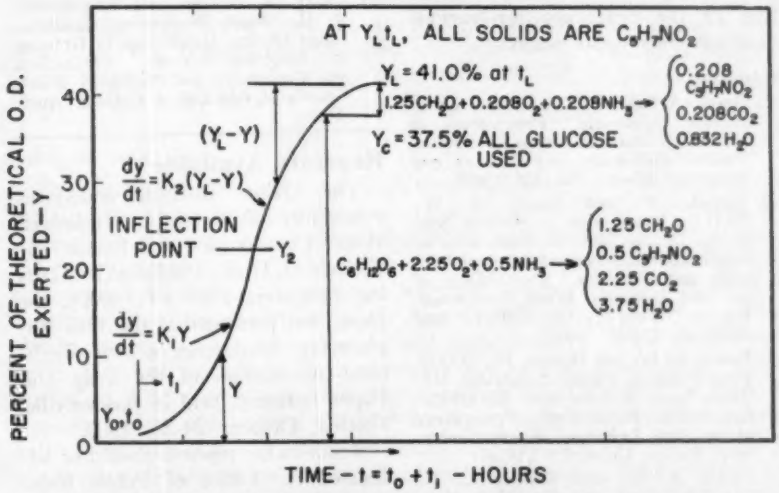

AT $Y_L t_L$, ALL SOLIDS ARE $C_5H_7NO_2$
Y_L = 41.0% at t_L
$1.25CH_2O + 0.208O_2 + 0.208NH_3 \rightarrow$ 0.208 $C_5H_7NO_2$, 0.208 CO_2, 0.832 H_2O
Y_c = 37.5% ALL GLUCOSE USED
$(Y_L - Y)$
$\frac{dy}{dt} = K_2(Y_L - Y)$
INFLECTION POINT
Y_2
$C_6H_{12}O_6 + 2.25O_2 + 0.5NH_3 \rightarrow$ 1.25 CH_2O, 0.5 $C_5H_7NO_2$, 2.25 CO_2, 3.75 H_2O
$\frac{dy}{dt} = K_1 Y$
t_1
Y
Y_0, t_0
PERCENT OF THEORETICAL O.D. EXERTED - Y
TIME - $t = t_0 + t_1$ - HOURS
0
10
20
30
40

Fig. 17. SUMMARY OF EXPERIMENTALLY verified mathematical and biochemical progression of bacterial degradation of glucose.

for bacterial growth. Garrett and Sawyer[7] delineated a discontinuous function for non-flocculent cells in heterogeneous mass culture and showed no significant deviation from pure culture growth patterns. Gram[8] and McCabe[9] subsequently postulated mathematical models for the activated sludge process based on Garrett's results.

In the present study using very small initial concentrations of organisms as contrasted to the published mass culture work, the use of a continuous function identical to that used in forecasting the growth and limits of any biological population was elected. This procedure was tested by applying a continuous function composed of two exponential

equations to three experiments selected from a two-year compilation. Figure 16 shows the experimental data used to evaluate the reaction velocity constants and the calculated data based on these constants. Note the divergent experimental environments represented. Substrate concentration ranged from 5.9 to 300 mg/l with seed concentrations of 5 to 200 mg/l; ranging from sewage to activated sludge. All seed was filtered through No. 2 Whatman paper to minimize predator and suspended solids interference.

On the basis of the data obtained, a summary of the postulated mathematical and biochemical progression of the aerobic bacterial degradation of glucose is presented in Figure 17. The coordinates y_o and t_o represent the first experimental analysis showing net oxygen uptake and hence growth. Although Y_L is theoretically reached only at infinite time for the formulation proposed, the data approach sufficiently close to Y_L to permit the use of the equation without significant error. As will be seen subsequently, the two control points of 37.5 and 41 per cent are especially significant and have been experimentally substantiated in mass cultures.

If the curves described by the postulated continuous function were symmetrical about the inflection point, the average of k_1 and k_2 would represent the average growth rate and the mean solids age could be approximated. Since symmetry is not a necessary characteristic the mean solids age would be more nearly represented by $\bar{t}$, the time coordinate for the centroid of the area under the curve, measured from t_o. This value can be mathematically determined, with some effort, as shown in Figure 18. Data are plotted for the three experiments delineated previously in Figure 16.

Correlation between solids production in bench-scale bio-oxidation units and in the BOD bottle, both as functions of solids-age, has been presented in detail elsewhere[3]. However, the best evidence of the validity and reproducibility of the relationship between short-term BOD and bio-oxidation solids production is shown in Table III. Here data published by Gaudy and Engelbrecht [10] for Warburg studies using mass heterogeneous cultures of acclimated organisms are used to check the validity of predictions based on the theory presented herein. At the two check points of 37.5 and 41 per cent of the theoretical oxygen demand, predicted values of 10.49 and 9.0 are compared to observed values of 10.60 and 9.0 milligrams of solids produced per milligram of theoretical oxygen demand removed.

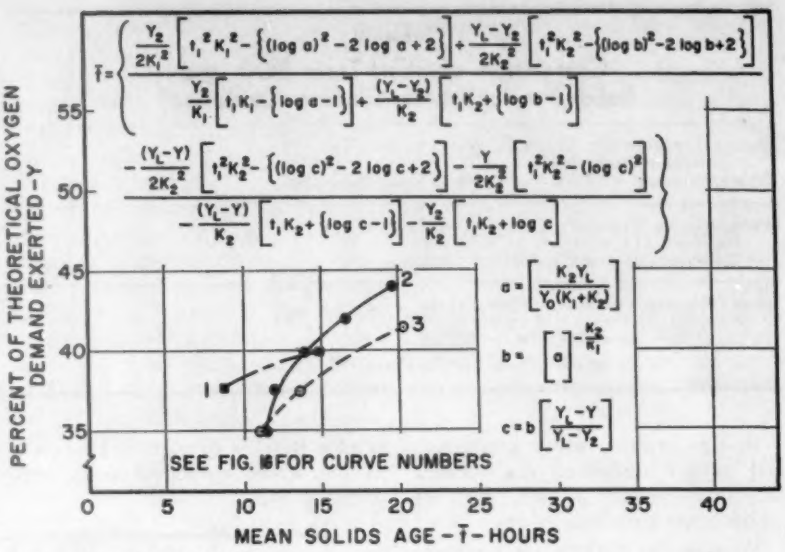


Fig. 18. MATHEMATICAL formulation for BOD progression vs. solids age at 20°C.

Current and Future Work

This report includes work done under NIH Research Grant RG5534. Current work is directed toward the utilization of the information presented for attainment of a 24 hour total oxygen demand test. Future work will be concerned with validation of the procedure for various heterogeneous waste waters.

References

1. Busch, A. W., "B.O.D. Progression in Soluble Substrates." *Proceedings of the 13th Industrial Waste Conference*, Purdue University and *Sewage and Industrial Wastes*, 30:1336 (1958).
2. Myrick, N. and Busch, A. W., "B.O.D. Progression in Soluble Substrates-II-The Selective Stimulation of Respiration in Mixed Cultures of Bacteria and Protozoa," *Proceedings of the 14th Industrial Waste Conference*, Purdue University (1959), and *JWPCF*, 32:741 (1960).
3. Busch, A. W. and Myrick, N. "B.O.D. Progression in Soluble Substrates,-III-Short-Term B.O.D. and Bio-Oxidation Solids Production", *Proceedings of the 15th Industrial Waste Conference*, Purdue University (1960).
4. Busch, A. W., and Sawyer, C. N. "Application of the Dropping Mersury Electrode to B.O.D. Determinations." Unclassified A.E.C. Document, N.Y.O. 4436, Contract No. AT (30-1)-621 (1952).
5. Clifton, C. E., "Oxidative Assimilation by Micro-organisms," *Enzymes*, Academic Press Inc., New York, II-2, 912 (1952).
6. Porges, N., Jasewicz, L. and Hoover, S. R., "Principles of Biological Oxidation," *Biological Treatment of Sewage and Industrial Wastes*, Vol. 1, Reinhold (1956).
7. Garrett, M. T., Jr., and Sawyer, C. N., "Kinetics of Removal of Soluble Substrates by Activated Sludge," *Proceedings of the 7th Industrial Waste Conference*, Purdue University, 1952.
8. Gram, A. L., "Reaction Kinetics of Aerobic Biological Processes," Report No. 2, I.E.R. Series 90, University of California, 1956.
9. McCabe, J., "Mathematical Formulations of the Biological Oxidation Process," *Proceedings 3rd Conference on Biological Waste Treatment*, Manhattan College, April, 1960.
10. Gaudy, A. F., Jr. and Engelbrecht, R. S., "Basic Biochemical Considerations During Metabolism in Growing vs. Respiring Systems," *Proceedings 3rd Conference on Biological Waste Treatment*, Manhattan College, April, 1960.

Reprints Available

The Mellon Institute announces availability of a reprint, "Industrial Water Conservation and Re-use" by Richard D. Hoak. Published in *Tappi* for February, 1961 (P. 40A), the paper was presented at the 15th Engineering Conference of the Technical Association of the Pulp and Paper Industry, held in Jacksonville, Florida, October 24-28, 1960.

Requests for reprints should be addressed to: Office of Public Relations, Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pa.

The second article of this series concerns utilizing the electric motor for . . .

Butterfly Valve Actuators—*Part II*

by A. L. MYERS
Allis-Chalmers
York Works
York, Pennsylvania

■ ELECTRIC MOTOR operated butterfly valves have found wide acceptance in water and sewage plants and in many industrial and other utility plants. They are used in all types of applications in the water and sewage field. Some of the standard water works applications are for the control of the usual filter influent, effluent wash and drain functions. An outstanding example of this type of application is the Torresdale Filter Plant in Philadelphia, Pennsylvania where the back wash cycle is initiated by pushing a button and the cycle proceeds to completion automatically. The cycle can be interrupted, and started again by merely pushing additional buttons. A small portion of the valves used in the plant are shown being assembled in Figure 1. Other applications are pump suction and discharge control on both high and low pressure systems and for bypassing various functions such as rapid sand filters, etc. Other uses include the regulation of pressure and flow in distribution systems and isolation of portions of systems. One of many unusual applications is the use of a time-clock controlled motor operated valve for furnishing off-peak water to a golf course in California.

There are many factors involved in applying electric motor operated butterfly valves. After the proper valve has been chosen the minimum information required for selecting the motor operator includes current characteristics, timing to fully stroke the valve, torque to actuate the valve, motor characteristics, and the requirements for any auxiliary equipment such as manual operation, extra limit switches, etc.

The basic electric motor operator consists of a reversible electric motor which operates through a speed reduction, which can be of the worm and gear type, spur gear or level gear type, or a traveling nut type, or any combination of these, to drive the valve shaft. Also, a set of switches which disconnect the current to the motor when the valve reaches the full open and full closed positions, or any intermediate position is required. To this basic unit many features can be added.

Sizing of Basic Unit

To select the proper size of the basic unit, the torque requirements of the valve and the desired operating time are required. The torque required to actuate the butterfly valve is a function of the flow, line pressure, and seating resistance. Minimum operator torque for most adverse conditions have been established by the American Water Works Association for rubber seated and metal seated butterfly valves as built to their standards and as described in AWWA bulletin C504-58 for rubber seated butterfly valves and bulletin C505-58 for metal seated butterfly valves. However, there are many applications where the most adverse conditions will never be encountered and the actual torque should be computed. By supplying the actual flow and shut-off conditions imposed on the butterfly valve to the manufacturer, the manufacturer can compute the actual required torque.

Features and Accessories

The motor usually furnished is one of three basic enclosures: a general enclosure, NEMA 1; weather-proof, NEMA 4; and explosion proof, NEMA 7. Other types can be furnished for very special applications if required. The motor can also be furnished with various insulations such as Class A, Class B and Class H as required. Motors are usually available for any voltage, phase, cycle and direct current. Most electric motor valve operators are designed for on-off service and consequently are normally equipped with intermittent duty motors rated for 5 or 15 minute service. When there are possibilities of prolonged operation, it is necessary to use either 30 minute duty motors, or continuous duty motors. For proportional control, a continuous duty motor is normally required. If precise positioning of the valve is required, the motor can also be equipped with magnetic brakes to eliminate any motor drift.

Limit switches, in addition to those required to limit valve travel, can be supplied for actuating position indicating lights, for interlocking valve action with related equipment, etc. When extra switches are required, the type, rating, and number of contacts should be specified. Another type of switch which is required on all but light duty operators is one that will stop the motor when excess torque conditions are encountered, such as obstructions in the valve, seized bearings, etc. This torque switch can be installed to function when the valve is closing, or opening, or two switches can be supplied to fully protect the valve and operator in both opening and closing cycles.

When there is an electric failure, the electric motor operated valve remains in the last position, except for those equipped with dual motors and standby power and the necessary interlocking relays. In many cases, it is desirable to have the operator equipped with an auxiliary handwheel for manual operation on power failure. The auxiliary handwheel can be furnished in various types. One type is where the handwheel is engaged by depressing a clutch lever with the handwheel being automatically disengaged when the motor is energized. The handwheel does not turn the motor rotor and the motor will not turn the handwheel. This type is called motor preference. In the manual preference type, the handwheel is pulled out to operate manually and must be pushed in to return to motor operation. There are various other types such as continuously connected handwheels which turn every

time the motor runs and a removable handwheel which fits over the nut. This latter type can be fitted with an interlock device so the motor operator cannot be operated unless a cover is placed over the nut.

A reversing mechanism, such as a controller or switch, must always be furnished to actuate the valve. For the small motor operator designed for single phase current, a simple single pole, double throw switch is normally sufficient. However, for larger motors and multiple phase applications, a reversing relay controller is necessary. In addition to the relay an actuating device is required. Where the application only requires the valve to be fully open or closed, a simple station with open, stop and closed push buttons is normally sufficient. Of course, refinements of the push button station such as indicating lights, are frequently desired. The normal practice is to have a red light and a green light with red indicating closed, green indicating open and both an intermediate position.

In addition to the manual push button station, many other devices can be used to control the motor operated valve in response to many variables such as pressure, flow, level, density, weight, thrust, temperature, position, etc. These devices can originate a simple on-off signal which merely opens or closes the valve. This type of operation is desirable when the motor operated butterfly valve is used on pump discharge service and the actuating device is a contact in the pump motor controller. They can also originate any proportional signal which will position the valve such as a pressure or flow regulating device. Positioning is usually accomplished by utilizing an electronic relay which incorporates a Wheatstone bridge. This application is illustrated by the simple diagram in Figure 2. The transmitter translates a signal, such as flow, level, etc. into a mechanical motion which actuates a slide wire or differential transformer which upsets the balance of the electronic relay. This causes a contact to close which energizes the reversing controller causing the valve to open or close as required. The movement of the valve also actuates a slide wire or differential transformer which feeds back to the electronic relay, and then the circuit in the relay is balanced a contact is open which, through the reversing controller, stops the valve action.

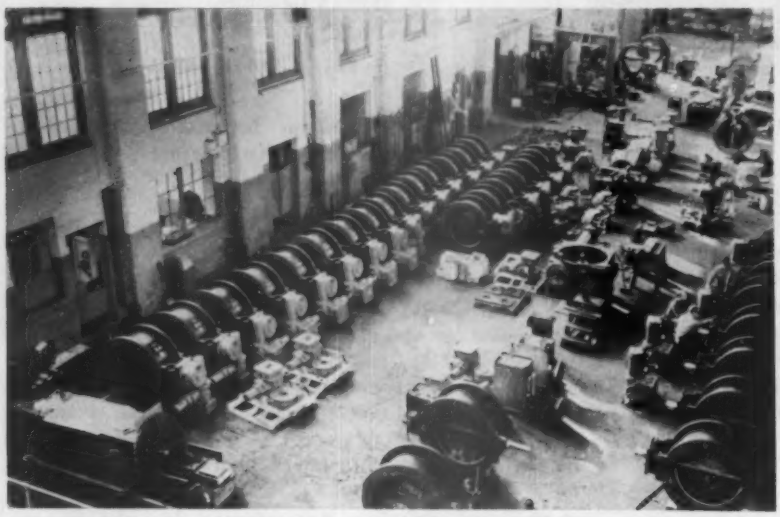


Fig. 1. RUBBER SEATED butterfly valves on assembly floor.

Many times it is desirable to know the valve position. As related before, one means is the use of indicating lights, but this only indicates whether the valve is in the fully opened, fully closed, or in an intermediate position. By equipping the motor operator with a slide wire the valve position can be indicated on a voltmeter calibrated in per cent or degrees open. For very accurate position indication, Selsyns can be used.

There are many refinements which can be obtained from the various manufacturers, and every year more refinements are being introduced. In the past several years, the reversing contactor has been removed from its separate wall mounted enclosure and has been incorporated within the motor operator enclosure. Push buttons and indicating lights have also made the same move to the operator enclosure. These integral controls are particularly advantageous where the valve is to be controlled locally, where space is at a premium, where the location is outdoors, etc. There also is the economy of lower installation and maintenance cost. Another innovation is the two-speed operator which uses a change of speed gear box actuated by magnetic clutches. This feature can be used for pump check service where it might be desirable to slowly close the valve to an almost closed position to avoid water hammer, then finish closing the valve rapidly to prevent backflow through the pump. As time goes on, more features will be added to make the electric motor operated butterfly valve one of the most versatile pieces of valve equipment on the market.

Operator Selection

To aid in the selection of the electric motor operator, the required basic information is tabulated as follows:

Available current characteristics—voltage, phase, cycle.
Valve torque requirements.
Time to fully open or close valve.
Type of enclosure and insulation.
Is auxiliary handwheel required? If so, what type?
Are additional limit switches required? If so, number required number of contacts per switch, rating and type, if special type required.
Type of operation—Open-close or positioning.

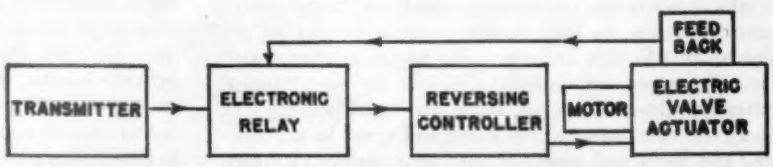


Fig. 2. BLOCK DIAGRAM for valve positioning control.

Accessory equipment such as reversing controllers, push button stations, slide wires, extra limit switches, etc.

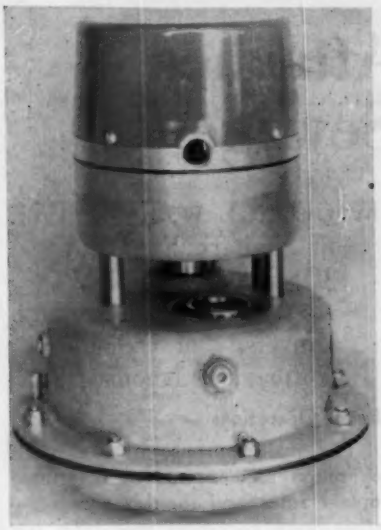


Fig. 3. SMALL VALVE actuator which can be mounted directly on the valve shaft.

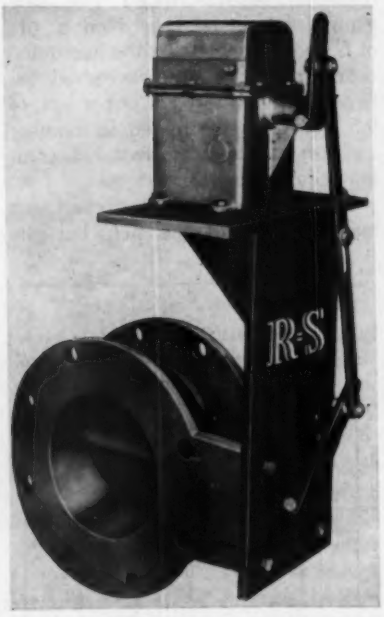


Fig. 4. A DAMPER motor which can be adapted for small valves.

To select the specific type, it is best to approach the various valve electric motor operator manufacturers as there are many types of electric motor operators available. For small valves, a small unit is available which can be mounted directly on the valve shaft and can be equipped with auxiliary limit switches, torque switches, continuously connected handwheel, etc. as shown in Figure 3. Also, for small valves, the various damper motors can be adapted with one example as shown in Figure 4. For larger valves, a larger, more rugged unit is required which is available from a number of operator manufacturers in almost every conceivable combination of features as described in this article. Some of these various operators are shown in Fig 5.

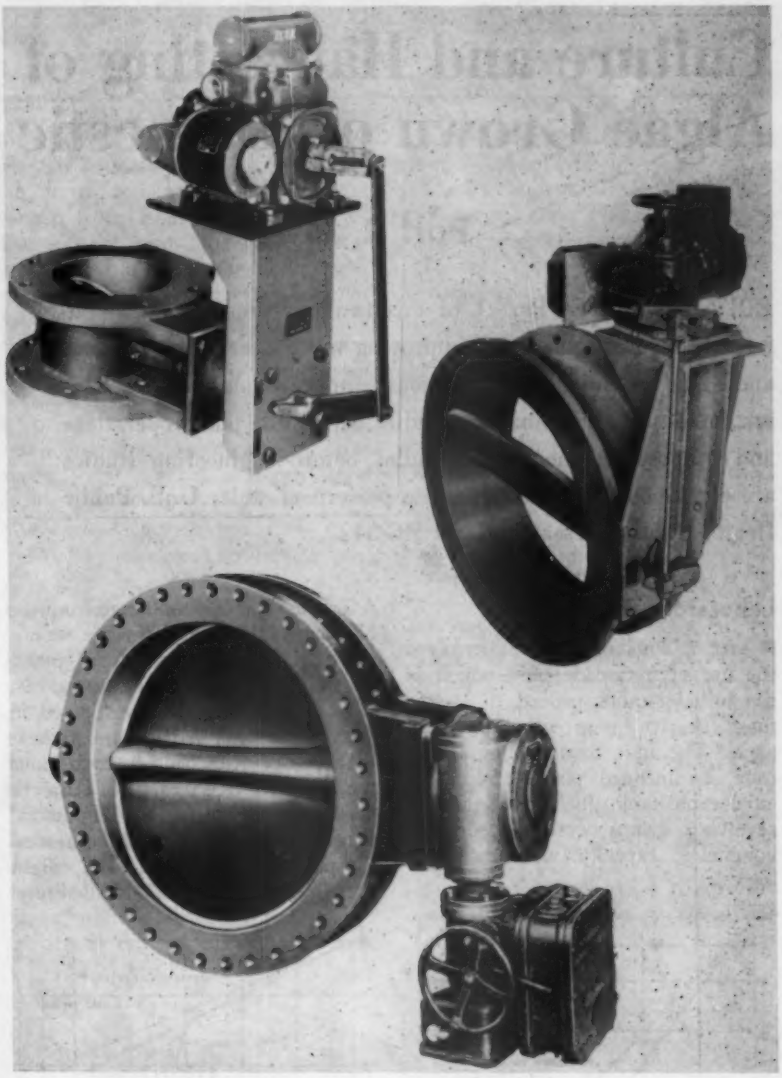


Fig. 5. VARIOUS OPERATORS for larger valves.

Wherever electricity is available, the electric motor operated butterfly valve provides efficient, reliable, automatic control of many operations.

Whitman, Requardt Retains M. C. Smith

Whitman, Requardt, Engineers, Baltimore, Md., announces that as of May 1, 1961, Marsden C. Smith, recently retired Chief Engineer, Department of Public Utilities, Richmond, Va., has become a consultant to the firm. Mr. Smith designed and supervised most of the water supply improvements in the Richmond system in recent years and is well-known for his work in water treatment. He developed coagulation equipment and an automatic pump control system. A long-time member of the American Water Works Association, he has been active on its committees, has contributed many papers, and has been elected an Honorary Member.

RESEARCH PROGRESS REPORT

Culture and Harvesting of Attached Algae Grown on Domestic Sewage

Part 2

by GEORGE W. REID, Prof. of Sanitary Eng. and JOSEPH R. ASSENZO, Asst. Prof. of Sanitary Eng. University of Oklahoma Norman, Oklahoma

EDITOR'S NOTE: Part 1 of this two-part presentation on attached algae as a means of improving wastewater plant effluents and algae potential as a food source appeared last month. This section describes laboratory studies and pilot plant operations and proposes further algae studies before engineering studies are continued. The work has been performed under U. S. Public Health Service Research Grant RG-5422.

Laboratory Studies

■ THE LABORATORY studies involved the use of a cascade unit, which in the initial studies proved to be the most effective for growth of attached algae. The unit consisted of a cascade, an inclined plane, and a recirculation tank, in which multiple revolving drums were placed. The volumetric capacity was four gallons.

Treated municipal sewage from the Norman, Oklahoma, Sewage Treatment Plant, a "bio-sorption" plant, was the liquid used in the studies. Two conditions were investigated in these uptake and growth and studies: a, batch operation, and b, continuous operation with recirculation. Analytical determinations included ammonia, nitrate, nitrite, total nitrogen, total phosphate, temperature, pH, light intensity, BOD, solids, and alkalinity.

Batch Operations

The main purpose of the batch operation studies was to determine uptake rates, and for this reason the algae were harvested only after the testing had been completed.

In one series of batch studies, the pH was controlled to determine the pH range at which best growth was obtained. It was found that best growth is obtained between a pH of 6.5 to 9.5; however, the maximum concentration of algae occurred between pH 6.5 and 7.5. At a pH of 9.5, the algae decreased in number and lost much of their color, becoming yellowish-brown.

In a second series no attempt was made to control the pH, but the

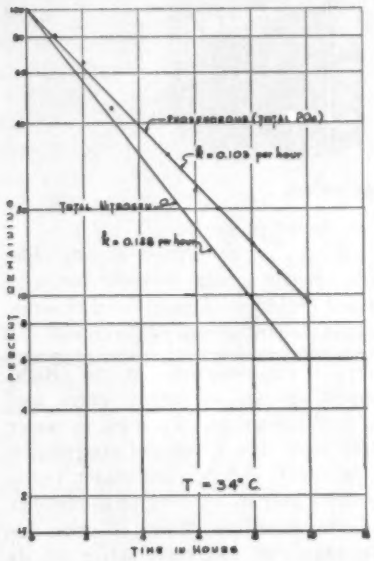


Fig. 1. LABORATORY STUDIES Batch Operation Series 1, using sewage treatment plant effluent.

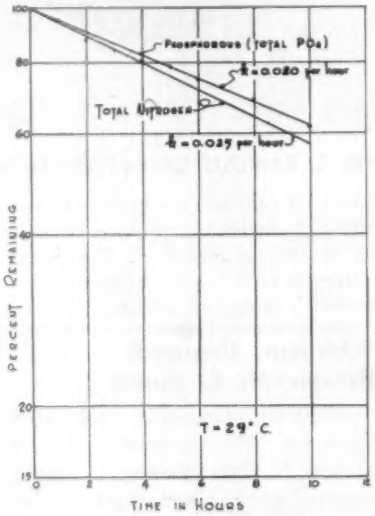


Fig. 2. LABORATORY STUDIES Batch Operation Series 2, using sewage treatment plant effluent after 24 hours aeration.

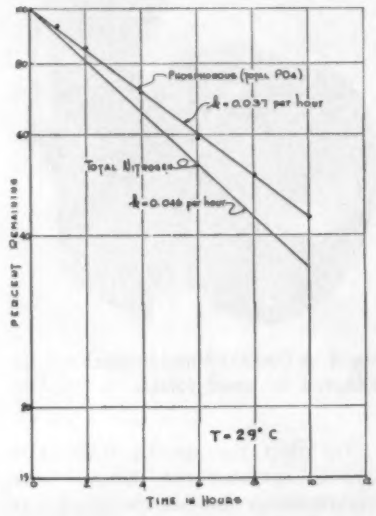


FIG. 3. LABORATORY STUDIES Batch Operation Series 3, using sewage treatment plant effluent with NH_4NO_3 added.

sewage was treated chemically or physically before being added to the unit on which the algae had been previously cultivated. Figures 1, 2, 3, and 4 show graphically the results of four series of tests. For each series the reaction velocity constant, or k value, was computed for both phosphorous and nitrogen uptake from the equation:

$$\log \frac{L_t}{L} = -kt \qquad (1)$$

where:

t = time in hours
L = initial concentration
L_t = concentration at time, t
k = reaction velocity constant per hour, (base 10)

Table 1 gives a comparison of the k values for the four series for a temperature of 20° C. These k values are quite low when compared to the k value obtained by Reid[25] in his slime studies. Reid obtained a value of 0.1 per hour for phosphorus uptake by slimes; the values obtained in this study vary from 13 to 60 per cent of Reid's value. It is believed that algae, cell for cell, take up nutrients at the same rate as slime, but that the difference in cell size accounts for the difference in k values, the cell size of algae being considerably larger than that of slime bacteria.

The k values also reflect the efficiency of the process. For example, for a two-hour retention time, referring to Figures 1, 2, 3, and 4 the per cent removal of phosphorus ranged from 10 per cent for Series 2 to 40 per cent for Series 1. Removal of nitrogen ranged from 10 per cent for Series 2 to 45 per cent for Series 1. These results indicate that a high retention time is necessary to reduce the concentration of these nutrients to a level low enough to prevent algal pollution in the receiving stream. One conclusion from these tests is that attached algal forms are "relatively inefficient" nutrient removers.

Another important economical consideration is surface area required for a given removal in a given period of time. In the results of Series 1, it took five hours to remove approximately two-thirds of the phosphorus. Assuming a one mgd sewage treatment plant and a ⅛ in. sheet of liquid over an algal growth, six acres of surface area exposed to the sunlight would be required for a five-hour retention period.

The BOD and solids analyses indicated, as was already known, that algae produce more organic matter than is in the original liquid. Therefore, frequent harvesting is necessary for an improved effluent.

The predominant algae found were *microspora* and *chlorella*; *microspora* in the greatest numbers.

The pH of the liquid was always between 6.5 and 9.5. Above a pH value of 9.0 the efficiency of nutrient removal fell off rapidly and the algal growths became yellowish-brown in color and clumpy.

It was found that attached algae may be harvested easily by scraping. Harvesting should be accomplished at some critical value of BOD, solids and pH; pH being the most important, rather than being just a visual and arbitrary decision.

Continuous Operation

The batch operations were performed mainly to measure the retention time required for the uptake or assimilation by attached algae. They did not indicate, however, how much algae, on a weight basis, this type of cascade apparatus could produce, nor did they provide much data which might be used to predict either pilot plant or full scale continuous operation. To accomplish these objectives, the next studies involved

Table 1
A Comparison of The k Values For A Temperature of 20°C

Series	k, Phosphorus		k, Nitrogen	
	per hour	per day	per hour	per day
1	0.053	1.27	0.067	1.61
2	0.013	0.31	0.017	0.41
3	0.024	0.58	0.030	0.72
4	0.061	1.46	0.072	1.73

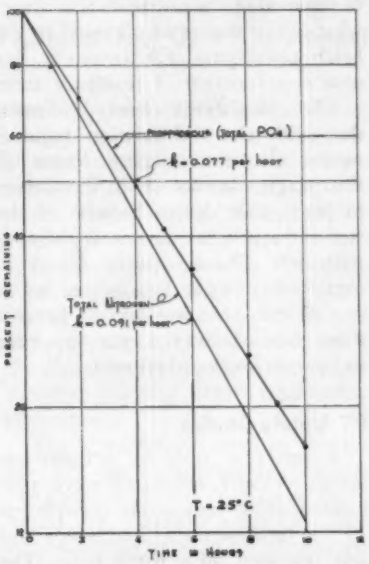


FIG. 4. LABORATORY OPERATIONS Batch Operation Series 4, using sewage treatment plant effluent chemically treated to precipitate phosphate and NH_4NO_3 added.

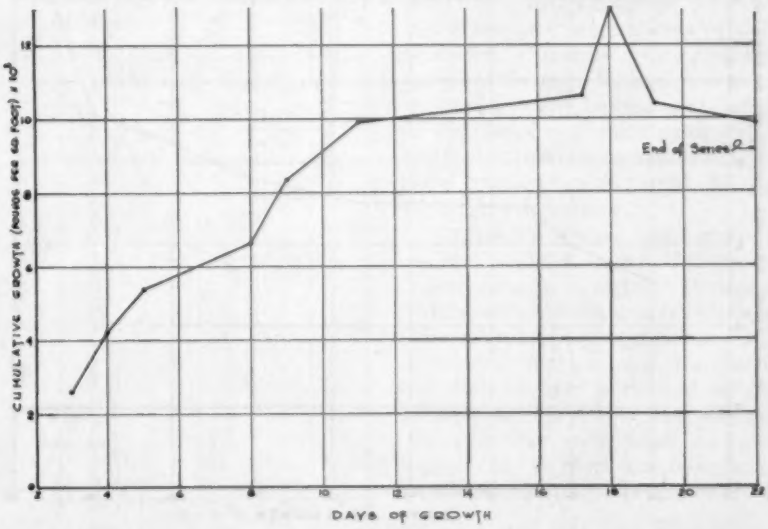


Fig. 5. LABORATORY STUDIES continuous operation Algal Growth, Series 1. Weights are dry weights.

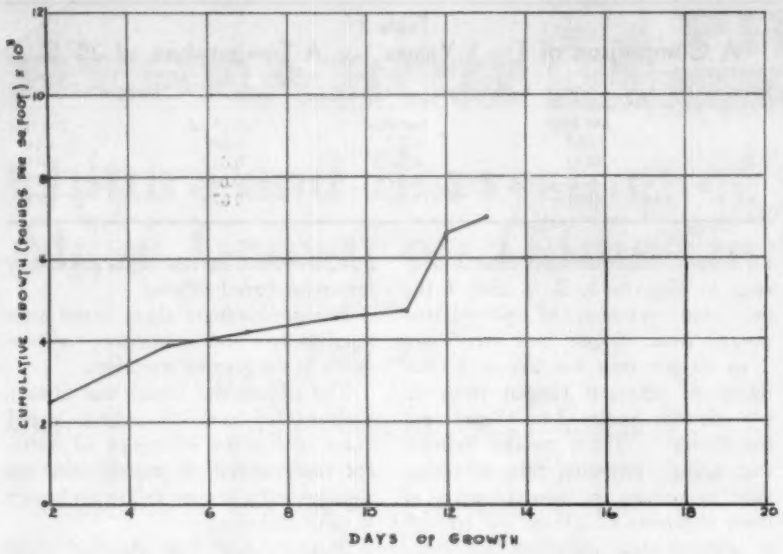


Fig. 6. LABORATORY STUDIES continuous operation Algal Growth, Series 2. Weights are dry weights.

continuous operation of the cascade unit. A larger recirculation tank was added to increase the retention time.

The same chemical and physical tests were performed. In addition, alternate steps on the cascade were harvested daily in order that accumulative weights might be determined. At various times, when the pH became too high, the entire unit was drained, cleaned and flushed, and a new growth started by seeding. *Microspora* and *chlorella* were the predominating species. Figures 5, 6, and 7 show the results of the cumulative growth studies for three series of tests. The characteristic humps on Figures 5, 6, and 7 reflect change in light intensity and indicate the unit was operating far below optimum light intensity. The source of light was a battery of flood lights. After maximum growth is obtained on the cascade, the attached algae slough because the layer of algae adjacent to the cascade surface receive little or no light, turn brownish-yellow in color and die. The phosphorus and nitrogen removals tapered off after 14 to 18 days growth without harvesting. After this time, the uptake of nutrients was beginning to be offset by that released by the dying algae.

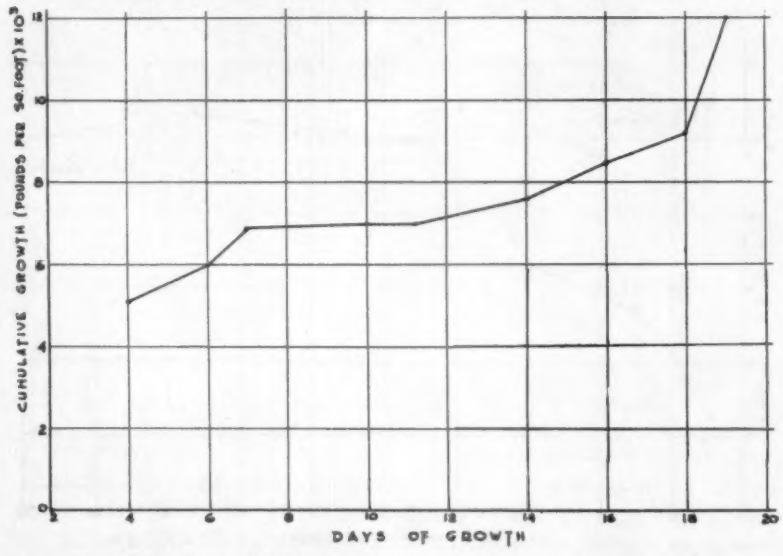


Fig. 7. LABORATORY STUDIES continuous operation Algal Growth, Series 3. Weights are dry weights.

Retention time and surface area were again limitations as they were with the batch operations. The problem of area required for the attached algal forms seems to be an insurmountable one. Based on the figures obtained in these studies, after a two-week growth time one ton of algae would be obtained from three acres of cascade provided the effluent was recirculated through an oxidation pond. Because the light intensity generally observed in this area of Oklahoma is much higher than was used in these studies, this same weight could be obtained in about one week rather than two weeks, if partial shading is used to obtain optimum light.

As was expected, the efficiency of removal of the nutrients was somewhat lower than that obtained in the batch operations. Efficiency in this case is a function of residence time.

The calculations clearly indicated that with the recirculation requirements, etc., the attached forms, at this stage, do not lend themselves to plant scale design because of the tremendous areas required. Mixing with free floating forms found in algal ponds might help some, but it would still be necessary to harvest these free floating forms in order to have an improved effluent.

P^{32} Uptake Studies

A series of tests to evaluate reaction velocity constants were performed using radioactive phosphorus (P^{32}). In these tests, the cascade unit was operated on a batch basis. The radiophosphorus was introduced into a synthetic sewage and this was fed into the algae seeded unit. The radioactivity was detected with a Geiger-Mueller (GM) tube which was placed two inches above the algal growth on one of the steps of the cascade.

Two series of tests were conducted. Figures 8 and 9 show the results of these tests. The k values were calculated in the same manner as previously described. The k value obtained from the results of Test 1, for 20° C, was 0.0215 per hour; for Test 2 the k value was 0.0224 per hour. Also plotted on Figure 9 is Reid's k value for the uptake of P^{32} by slime[25]. As can be seen from the figure, the k values for uptake of radiophosphorus by the attached algae are about one-tenth of the k value for the uptake of radiophos-

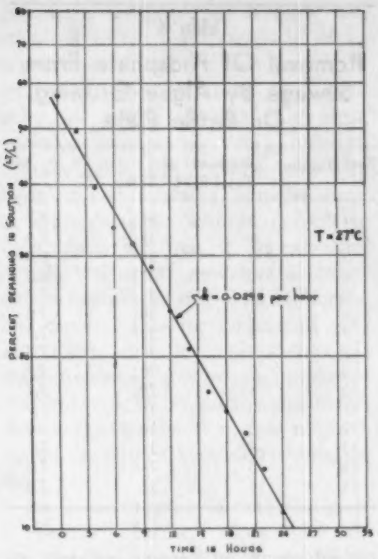


Fig. 8. UPTAKE OF P^{32} by attached algae, test no. 1, run no. 3 only.

phorus by slimes. This discrepancy is due primarily to the difference in total surface area or numbers per unit area of the slime and attached algae. The slime, of course, offers much greater surface area because of the smaller size cells. Also, the algae immediately next to the surface of the cascade receive but little of the necessary light in comparison to the algae nearest to the light source, thereby reducing their assimilation efficiency.

The k values obtained in the uptake of radiophosphorus compared favorably with the k values determined by chemical analysis. Table 2 presents the k values for phosphorus uptake by both methods.

Table 2

k Values For Phosphorus Uptake By Both Methods

	k Values, Per Hour, T = 20°C	
Test Number	Chemical Analyses	Radiophosphorus
1	0.053	0.022
2	0.013	0.022
3	0.024	
4	0.061	

At first glance at the results, they would seem to indicate that the k values determined by measurement of the radioactivity gave more consistent results than the chemical analysis method. Differences in the k values determined by chemical analysis reflect varying algal conditions during testing: age, pH, temperature, organic content, light intensity, etc. The algal conditions during both P^{32} tests were approximately equal.

The main conclusion drawn from this study is that the uptake efficiency of attached algae is relatively low. This indicates, again, that in actual practice the retention time required for safe removal of nutrients to prevent algal pollution of a stream must be high.

Pilot Plant Studies

The primary purpose of the pilot plant studies was to determine what could be grown day in and day out under the various weather conditions encountered in this area of Oklahoma. It was realized from the onset that much of the weather would be unsuitable and every advantage should be taken of the spring, summer and fall weather. Consequently, the pilot plants were placed in operation before the laboratory studies were completed.

Four plants were constructed, all of them based on the cascade principle. One was a cascade built of wood, the second, of concrete, the third, corrugated metal, and the fourth, a cascade with baffles made of concrete to increase the retention time. The units were constructed at the Norman, Oklahoma, Sewage Treatment Plant and were designed to receive sewage from the secondary settling basins. No recirculation was practiced.

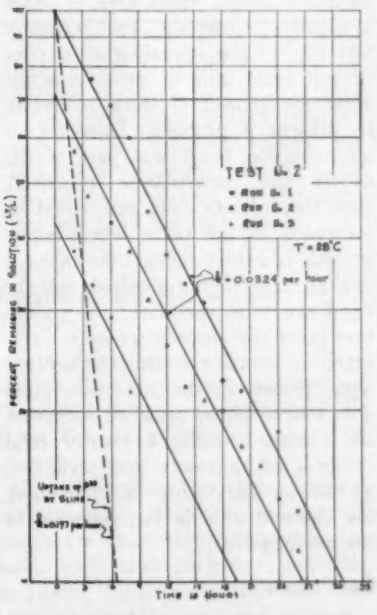


Fig. 9. UPTAKE OF P^{32} by attached algae.

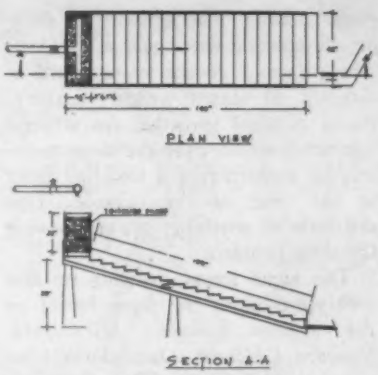


Fig. 10. PILOT UNIT, concrete cascade.

One of the primary considerations in the development of the pilot plant studies was to demonstrate what was being discovered in the bench scale studies could be duplicated under natural conditions. The units were placed into operation with varying degrees of success, and as more was learned they underwent continuous modification. The most pressing problems encountered were the attendant growth of sewage slime with the algae and the vicissitude of the weather, which ranged from overly intense sunlight to killing frosts.

Wooden Cascade

A wooden cascade was the first unit constructed. The results of the initial studies showed algae could be grown on the wooden cascade, but a problem would be encountered with the growth of slime during the night. The most dense growth of algae was on the vertical risers of the cascade. The risers, because of the positioning of the unit, were always partially shaded. The algae growing on the treads of the cascade, in a thin sheet of liquid, were burned and killed by the natural sunlight. Consequently, all further studies on outdoor units were conducted with partial shading of the growth surfaces.

The species of algae found growing on the cascades were: *Microspora*, (most dense), *Synedra*, *Urenema*, *Anabaena*, *Chlorella*, and *Oscillatoria*. The protozoa *Chlamydomonas* was also found on the cascade. No chemical analyses were performed on the effluent or influent of this unit as the unit was quite small and designed only to check out operational problems that might be encountered.

Concrete Cascade

Figure 10 is a plan of the con-

crete cascade. The growth of slime on the cascade was again a problem. The presence of the slime made it difficult to obtain weight measurements of algal growths. An attempt was made to alleviate the slime problem by constructing a trickling filter at the head of the cascade. This did little, if anything, toward solving the slime problem.

The algae found growing on this unit were about the same found on the wooden cascade: *Microspora, Synedra, Chlorella, Oscillatoria, Urenema,* and *Anabaena*. The slime contained protozoa, fungus, bacteria and worms.

The algae-slime mixture was difficult to dry and became anaerobic rapidly. Consequently, good weight measurements were hard to obtain.

The flow rate over the unit was one gallon per minute initially and then increased to three gallons per minute. The higher flow rate washed most of the slime from the cascade without dislodging much of the attached algae. The average retention time was 20 to 30 seconds. Physical and chemical analyses were conducted at least daily. As might be expected there was little or no removal of the nutrients with such a small contact period. Table 3 shows the results of 22 analyses for phosphate. As can be seen in the table, about 70 per cent of the analyses indicated no measurable removal. However, when there was removal, it was rather high for the short contact time existing. When high removal occurred, the concentration of algae-slime mixture, especially slime, was very high.

Table 3
Removal of Phosphate From Sewage By Algae Growing On Concrete Cascade

Test Number	pH	Temp. °C	% Removal of Total PO4
1	7.9	30	0
2	8.4	32	23
3	8.0	28	0
4	7.9	29	0
5	8.0	26	47
6	7.9	28	35
7	8.1	29	0
8	7.9	28	14
9	8.0	30	0
10	7.9	31	0
11	8.1	31	0
12	8.3	31	0
13	7.9	32	0
14	8.0	29	0
15	7.9	29	0
16	8.4	30	7
17	8.3	30	7
18	8.3	30	0
19	8.1	30	0
20	7.9	30	0
21	7.9	30	0
22	7.8	29	0

Baffle Unit

The concrete baffle unit was placed into operation shortly after the concrete cascade unit. The rate of application of sewage varied from one gallon per minute to three gallons per minute. A rock bed was installed, with no success, at the influent end of this unit in an attempt to decrease the slime problem. The contact time was three minutes.

The algal growth in this unit was not as abundant as it had been on the concrete cascade. Harvesting of the algae-slime mixture was difficult because of the design of the unit. *Oscellatoria, Synedra,* and *Chlorella* were the main species of algae found growing on the unit. Results of the physical and chemical analyses were similar to the results obtained with the concrete cascade. Table 4 shows the results of the unit for phosphate removals. As can be seen in the table, half of the time there was no measurable removal of the phosphate. Of the instances when removal occurred the maximum removal was only 10 per cent. This was due primarily to the lack of contact time and reflects the greater growth of slime on the concrete cascade unit.

The pilot studies indicate: a, a once-through system is completely inadequate unless much area is made available to increase the retention time; b, in the operation of a pilot or full scale unit to grow attached algae the growth of slime is certain to present a problem. However, if an oxidation pond was part of the set-up and recirculation practiced, then the influent flow rate could be increased to the point where slime growth is kept minimal, the influent sewage more highly nitrified, and the residence time adequate; the oxidation pond and cascade set-up is preferable to simple recirculation because algae grown in the oxidation pond will adhere to the attached forms on the cascade causing a greater total removal of nutrients and algae; c, as far as harvesting is concerned, the cascade unit is far superior to the baffle system.

Table 4
Removal Of Phosphate From Sewage By Algae Growing On Baffle Plate

Test Number	% Removal of Total PO4	Temp. °C	pH
1	3	34	7.7
2	4	35	7.9
3	0	36	8.0
4	10	37	8.0
5	12	36	7.7
6	0	30	7.8
7	9	31	7.7
8	0	29	7.7
9	0	30	7.9
10	6	29	7.7
11	0	30	7.7
12	0	30	8.0
13	5	31	7.7
14	0	24	7.8
15	10	25	7.8

Conclusions

Experiments designed to explore the feasibility of developing an attached algae on sewage effluent to reduce the nutrient content of the sewage have been successfully conducted, and it can be concluded that attached forms can be grown on shallow water depth surfaces or on moving surfaces, and that these algae can substantially remove the nitrogen and phosphorus from the sewage.

An extensive literature research was first conducted for references to attached algae suitable for growth in sewage. Little was available. Secondly a field search, at sewage outfalls, in polluted streams, and at sewage lagoons, for attached algae suitable for culture was undertaken. Several promising species were collected and grown on bench-scale apparatus.

Both bench-scale and pilot-scale apparatus providing shallow water depth surfaces were constructed and were operated sufficiently long to arrive at the above conclusions. Numerous operational and laboratory difficulties were encountered but surmounted, including, particularly, species interaction and nutrition.

Though it has been demonstrated that attached algae can be grown, removed by scanning and will remove the phosphorus and nitrogen in the food sources, namely sewage, the residence time required for effective reasonable removals is not compatible with what one would desire for plant scale operation. Studies indicate it takes 5 hours to remove ⅔ of the phosphate with possibly ¼ growth exposed to subdued sunlight. Roughly calculating for 1 mgd capacity plant, it would require 6 acres of algae surface for 5 hours

retention, compared to a high rate trickling filter, requiring 1/30 of an acre of about 180 times more effective in use of area. The difficulty, of course, is that the algae surfaces require not only intimate contact with the sewage but also light. Slime surfaces can be built as multiple decks without respect to light. Area for area, it appears that attached algae are as active in nutrient utilization as free-floating forms, but the free-floating forms can present more algae per unit surface. It was envisioned that algae uptake of nutrients might be much more rapid, thus lowering retention time requirements than have been determined so far.

As a consequent of this study, it is believed further studies by algologists are needed before engineering-type studies can be continued on attached forms utilized to treat sewage effluent.

References

1. Oswald, William J. and Gotaas, Harold B., "Photosynthesis in Sewage Treatment," Proceedings American Society of Civil Engineers, Volume 81, Separate No. 686, (May, 1955.)
2. Gotaas, Harold B., Oswald, William J. and Golueke, Clarence, "Algae-Bacterial Symbiosis in Sewage Oxidation Ponds," Institute of Engineering Research, Berkeley, California, (December 31, 1954.)
3. Gotaas, Harold B., Oswald, William J. and Ludwig, Harvey F., "Photosynthesis Reclamation of Organic Wastes," *The Scientific Monthly*. Volume 79, No. 6, (December, 1954.)
4. Gotaas, Harold B. and Oswald, William J., "Light Conversion Efficiency in Photosynthesis Oxygenation," Algae Research Project, Sanitary Engineering Laboratory, University of California, Issue No. 6, I.E.R. Series 44, (January, 1957.)
5. Gotaas, Harold B. and Golueke, Clarence G., "Recovery of Algae from Waste Stabilization Ponds," Algae Research Project, Sanitary Engineering Research Laboratory, University of California, Issue No. 7, I.E.R. Series 44, (January, 1957.)
6. Oswald, William J. and Gotaas, Harold B., "Discussion . . . Photosynthesis in the Algae," *Industrial and Engineering Chemistry*, Volume 48, No. 9, (September, 1956.
7. Oswald, B. J.; Gotaas, H. B.; Golueke, G. G. and Kellen, W. R., "Algae in Waste Treatment," *Sewage and Industrial Wastes*, Volume 29, No. 4, (April 1957.)
8. Oswald, William J. and Gotaas, Harold B. "Photosynthesis in Sewage Treatment," Transactions, American Society of Civil Engineers, Volume 122, page 73, (1957.)
9. Oswald, William J.; Hee, Richard J. and Gotaas, Harold B., "Studies of Photosynthetic Oxygenation 1. Pilot Plant Experiments." Sanitary Engineering Research Laboratory, University of California, Issue No. 9, I.E.R. Series 44, (January, 1958.)
10. Geigel, A. R., "Effects of Boron on the Growth of Certain Green Plants," *Journal of Agriculture*, University of Puerto Rico, Volume 19, pages 5-28, (1935.)
11. Sawyer, Clair N., "Some New Aspects of Phosphates in Relation to Lake Fertilization," *Sewage and Industrial Wastes*, Volume 24, 768, (1952.)
12. Curry, John J. and Wilson, S. L., "Effect of Sewage-Borne Phosphorus on Algae.' *Sewage and Industrial Wastes*, Volume 27, No. 11, (November, 1955.)
13. Ludwig, Harvey F. and Oswald, William J., "Role of Algae in Sewage Oxidation Ponds," *The Scientific Monthly*, Volume LXXIV, No. 1, (January 1952.)
14. Gerloff G. C.; Fitzgerald, G. P. and Skoog, F., "The Isolation, Purification and Nutrient Solution Requirements of Blue-Green Algae," The Culturing of Algae, Charles F. Kettering Foundation, (1950.)
15. Kratz, William A. and Meyers, Jack, "Nutrition and Growth of Several Blue-Green Algae," *American Journal of Botany*, Volume 42, (March 1955.)
16. Silvia, Paul C. and Popenfuss, George F., "A Systematic Study of the Algae of Sewage Oxidation Ponds," State of California, State Water Pollution Control Board, Sacramento 14, California.
17. Rudolfs, Willem, "Phosphates in Sewage and Sludge Treatment. I. Quantities of Phosphates," *Sewage Works Journal*, Volume 19, page 43, (1947.)
18. Burlew, John S., "Algae Culture from Laboratory to Pilot Plant," Carnegie Institution of Washington, Publication 600, Washington, D. C., (1953.)
19. Kessler, Erich, "Role of Photo-chemical Processes in the Reduction of Nitrate by Green Algae," *Nature*, Volume 176, No. 4492, (December, 1955.)
20. Lackey, James B., "No. 65-How the Biota of Sewage and Industrial Wastes Work for Us," *Wastes Engineering—Sewage and Industrial*, Volume 25, No. 12, (December, 1954.)
21. Palmer, C. Mervin, "Discussion . . . Photosynthesis in the Algae," *Industrial and Engineering Chemistry*, Volume 48, No. 9, (September, 1956.)
22. Reid, George W., "Culture and Harvesting of Algae Grown on Domestic Sewage," Public Health Service, National Institute of Health, Grant No. RG-4900, University of Oklahoma Research Institute, Norman, Oklahoma, (September, 1957.)
23. Letts, E. A., "On the Occurence of the Fresh-Water Alga *Prasiola crispa* on Contact Beds," *Journal Royal Sanitary Institute*, Volume 34, pages 464-508, (1913.).
24. Gloyna, E. F.; Herman, E. R. and Drynan, W. R., "Technical Report #2, Oxidation Ponds—Waste Treatment Studies, Radioisotope Uptake and Algae Concentration," Atomic Energy Commission, Contract AT-(11-1)-220; June 1, 1955, University of Texas, Department of Civil Engineering, Sanitary Engineering Laboratory, Austin, Texas.
25. Rorschach, R. and Reid, G. W., "A Study of Biological Sewage Oxidation Using Radiophosphorus as a Tracer," *Sewage and Industrial Wastes*, Volume 24, No. 10, (October, 1952.)

Annual Report: Metropolitan Corp. of Greater Winnipeg Sewage Disposal Branch

The cost of operation and maintenance of the Greater Winnipeg Sanitary District reached $653,422 which was 100 percent of the operation, according to the Metropolitan Corp. of Greater Winnipeg, Sewage Disposal Branch, Annual Report.

The mileage of water mains and sewers and the number of services and sewer connections within the Greater Winnipeg area continued to increase. The largest percentage of increase was made by the municipalities that surround both Winnipeg and St. Boniface.

About 30 miles of mains were laid in 1960.

The total cost of general administration was $74,388.54 and the debt charge was $205,409.69 totaling $279,798.23.

The cost of operation and maintenance of the collection system was $113,559.62 while the cost of operation and maintenance of the main plant was $260,064.33.

Disposal of Hazardous Wastes

The latest in a series of safety guides, SG-9, on the disposal of hazardous wastes, is now available from the Manufacturing Chemists' Association, Inc.

The pamphlet outlines recommended safe practices and procedures for disposal of flammable liquids, toxic and corrosive materials and other substances which may create air or stream pollution problem.

The safety guide recommends that both a "hazard index" and a "disposal index" be established which would set out both the hazards of the waste material and the proper method for disposal.

The safety guide also urges that all waste disposal procedures be placed under the responsibility of one individual or department and that the plant safety organization act in a consultative capacity. Cooperation of the industrial hygienists or medical division also is required, the safety guide states.

The pamphlet describes several methods of disposal including open burning, burning in incinerators, disposal through sewers, and disposal by burying.

SG-9 is available from the Association at the headquarters office, 1825 Connecticut Ave., N. W., Washington 9, D. C. for 20 cents a copy.

Partially Oriented on . . . .

Stamp Duty

■ I HAVE HAD a rubber stamp made for my personal use. It has a box all around it, and it describes who I am —rather too briefly now I come to think about it considering the hard work I have put in in my time. There is a row of dots .....in the middle for my signature, and a row of ..... at the bottom for my date stamp. This is because I have acquired a date stamp as well. I also have the purple ink pad that goes with these things.

Of course it was mistake to have the date stamp separate. But with no one to guide me in these matters I just didn't know. The date stamp is quite all right in itself; it will, in fact, take me right up to 39 DEC 1966. It is its separateness which causes a little trouble. However, more of that later.

The first week I used these implements was most enjoyable. People padded subserviently into my room, laid some papers reverently on my desk, and backed away, saying— "For you to Sign, Sir." Directly the door was closed I would get out the ink pad, adjust the date on the stamp, knead up the ink pad and get cracking.

There are some people with complex minds who would consider that a Topline Signature Man ought to have his papers pre-stamped before they are presented to him, but these people miss an innocent pleasure. There is a magic in applying an Official Stamp to even the scruffiest of pocket-worn receipts. A chit from Woolworth's for "½ doz yellow dusters" takes on a splendidly official air when hit with my personal stamp and signed with my personal un-forgetable signature.

The second week of this business I had to remind people that I still wanted to sign things. I indicated that it was a system we were running. Those who persisted in Active Work without my Authority might find themselves liable to pay out of their own pockets for anything from a one-and-six penny duster to twenty thousand tons of hardcore.

Apparently the word went around about this, and people began collecting up anything they didn't want to be responsible for and put them on my desk for signature. (There is a fault in every system). Looking back on it, all would have gone well if the strain of so much responsibility for signing had not made it necessary for me to have a short rest. When I got back I was surprised at the result that both time and energetic gleaning had brought about. I am a single person with a single date stamp, and 1 No. box stamp. Besides, I am not the sort of person constitutionally fitted for mass production methods. My productions are of the individualistic "1 No. of" type—good of their kind, unrepeatable, and sometimes saleable. Ask me to undertake mass production and quality drops off.

The defect of a box stamp is that one does not know which way up it is until it is lifted off the paper; the additional defect of a *separate* date stamp is that it needs considerable aim to get in on the right dotted line, —or one fills up the "space reserved for signature" which is irritating to a conscientious mind. After a while, impatience got the better of my aim; after a further while a stampers hiccup attacked my right arm which continued its reciprocating up-and-down motion, irrespective of whether my left arm had managed to turn over the page or not. My mind began to go off the matter in hand, my operational sequence fell further apart and I became so exhausted that I had to go in search of a cup of tea. When I got back a sample check of results showed—

No. of documents believed aimed at	75
No. of boxes right way up	7
do. wrong do.	56
Date in box right way up	2
No. of documents unmarked in any way	11
No. of torn documents	23

(If there should be any accounting discrepancy in these results the error is also mine). I began to wonder if this effort was worthwhile and I started to thumb over the papers presented to me. This inspection was revealing, and it became apparent that I was a Victim to somebody else's system, not yet properly worked out. Somewhere along the line of documents to me I detected a serious fault in organization.

For instance I could track down some fellow who seemed to spend his whole life picking up picks and saying—"Ah, better send in a requisition to sharpen that one." So in they came to my desk—"Sharpen 3 picks"; "Sharpen 2 picks"; "Sharpen 3 picks". Another chap was asking for "Mend 1 puncture"; "Mend 1 puncture" day after day. Yet another seemed to want to order a 1000 lb of nails in "2 lb. 2" nails"; "2 lb. 2" nails" lots, form by form, until he got somewhere near satiety. What with these fellows and the ones wanting "5 bags cement"; "5 bags cement"—I came to the conclusion that the whole thing was too dreary for the artistic mind of an engineer to deal with.

So I rang the bell for my trusted assistant, and passed to him the Stamps of Office and my Authority to Sign. It was heartwarming to see the crease of pleasure that passed over his face as he realized the trust and confidence I placed in him. He looked almost as pleased as if I had suggested it was time he had a raise in salary. I hope he will be coming back to see me again soon because this new lot of papers for signing is getting rather a nuisance on my desk.

Detergents and Water Supplies*

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What Are They

■ THE WORD *detergent* when used as a noun is defined as a cleansing substance. In a broad sense water, abrasives, solvents, soap, and the so-called synthetic detergents are all cleansing substances and therefore are detergents. In this discussion we shall limit ourselves to ordinary soaps and the relatively new synthetic detergents.

Soap

First, let us consider what soap is so that we may better understand the difference from synthetic detergents. Fats react with alkalies to form soap, the reaction being termed *saponification*. Thus, soaps are salts of fatty acids. The ordinary toilet and laundry soaps of commerce are chiefly mixtures of sodium salts of stearic, palmitic, and oleic acids.

Soap is prepared commercially by boiling animal or vegetable fats with sodium hydroxide. The character of the soap formed is dependent largely on the fatty acids present in the fat. If a high percentage of sodium palmitate and sodium stearate are formed, the soap will be firm in texture. If, however, the soaps of unsaturated fatty acids are formed, such as sodium oleate, the soap will be soft and perhaps liquid at ordinary temperatures. This explains why many oils are unsatisfactory for soap making without first being saturated by hydrogenation. Soaps made from fatty acids with less than 12 carbon atoms in their configuration have low detergent properties but suds freely while those made from fatty acids containing more than 18 carbon atoms do not dissolve readily in water at ordinary temperature.

The sodium and potassium soaps are the only common soluble soaps. The other metallic soaps are insoluble in water. Thus, when a sodium soap is added to water containing calcium and magnesium ions, these metallic ions replace the sodium in the soap and insoluble calcium and magnesium soaps are precipitated effectively softening water by removal of the calcium and magnesium. The insoluble calcium and magnesium soaps cling to clothes in laundering and are difficult to rinse out. As a method of softening water, soap is expensive in comparison to ion exchange or lime-soda facilities and is very wasteful of soap because soap exerts no cleansing action until it has first reacted to remove all the calcium and magnesium ions from the water. In addition, the precipitated hardness in the form of insoluble soaps remains in the water.

Soaps other than sodium types are manufactured commercially. Soft or liquid soaps usually are potassium salts of the unsaturated fatty acids. The tincture of green soap used in hospitals is a solution of potassium soap in alcohol. Zinc stearate is a component of most talcum powders. Lead, manganese, and cobalt soaps are used in paints as driers. Some calcium soaps, which are soluble in oil, are components of lubricating greases. Ferric stearate is used as a leather dressing.

The packaged product commonly used in the household contains up to 90 percent of soap but also contains builders such as polyphosphates, dyes, and scents. The terminology would be more descriptive if these materials were referred to as soap detergents and thought of as a compound product containing soap as the surface-active agent and major constituent plus various builders included to enhance effectiveness and saleability.

Synthetic Detergents

Synthetic detergents are cleansers that contain one or more synthetic surface-active agents often referred to as *surfactants* instead of soap in their formulations. It must be realized that while there are a vast number of synthetic surface-active compounds available in commerce not all are ideal for household use.

In general, surface-active agents may be classified as anionic where the active portion of the molecule is an anion, cationic where the active portion of the molecule is a cation and nonionic where ionization does not take place. By far the greatest use of these materials is of the anionic type. Of the anionic compounds available, alkyl benzene sulfonate predominates in use. For convenience we shall refer to alkyl benzene sulfonate as ABS.

ABS is produced by polymerization of propylene derived from petroleum. It has the qualities desirable in a detergent, that is, relatively unaffected by hardness, effectively lowers surface and interfacial tension, wets, emulsifies and disperses soil and as a result is practically an ideal component of cleansing compounds. Certainly there are other surface-active agents reaching our water supplies but most of our attention has been directed towards ABS as the principal one encountered and an index to relative concentrations. In addition there is evidence that ABS is more resistant to degradation in waste treatment facilities and by natural processes in ground and surface waters.

In the formulation of synthetic detergents the packaged product may contain about one third or less actual surface-active agent, the remainder consisting of builders used to improve the cleansing properties or consumer appeal. Among the additives found in the final product are the following:

*Presented at the Annual Meeting, Mich. Section, AWWA, September 21, 1960.

Sodium tripolyphosphate
Sodium hexametaphosphate
Sodium phosphate, tribasic
Tetrasodium pyrophosphate
Sodium bicarbonate
Sodium carbonate
Sodium carboxymethylcellulose
Sodium metasilicate
Sodium silicate
Sodium chloride
Sodium sulfate
Scents, dyes and bleaches

It is interesting to note that because of the much lower percentage of synthetic surface-active agent in synthetic detergents as compared to soap as the surface-active agent in soap detergents, the net amount of actual surface-active agent being used has decreased even though the population has increased since their advent.

Analytical Determinations

No analytical methods for the determination of ABS are given in the tenth edition of Standard Methods.[1] However, at the time of this writing it has been announced the eleventh edition will include both infrared and methylene blue tentative procedures.[2] An American Water Works Association Task Group Report on analytical methods was published in the October 1958 Journal.[3] The report gives background information on the synthetic detergent problem and analytical methods for ABS. Both the methylene blue and infrared procedures are given in detail and are probably similar to the tentative procedures to be found in the eleventh edition of Standard Methods.

Infrared Method

This method is complex requiring considerable time, expensive equipment and skill. It is specific for anionic surface-active agents and most certainly is useful as a reference method and in research institutions. However, there is doubt that it will receive much use in routine water treatment plant analyses.

Methylene Blue Method

This method will measure ABS concentration plus the possible effect of certain interferences. If the test shows zero or relatively low (under 0.5 ppm) results, there is no particular need to resort to more complicated techniques. If a high result is found and the situation warrants the effort, the purification steps of the infrared method could be followed using a colorimetric (methylene blue) finish.[3]

Stated in simple terms the principal of this method is that methylene blue is soluble in water and not in chloroform. Chloroform is not soluble in water and being heavier than water will separate to form a layer even after thorough mixing. If ABS is present in a water sample, it will combine quantitatively with methylene blue to form a salt that is soluble in chloroform but not in water. In other words, the blue salt formed by methylene blue and ABS in a water sample can be extracted from the water-methylene blue solution with chloroform. An outline is presented below to illustrate the technique. No attempt is made to cover the details necessary for a workable method as this information will be in Standard Methods.

1. Select a simple volume based on estimated concentration of ABS. If less than 100 ml dilute to 100 ml with distilled water.
2. Acidify and transfer to separatory funnel.
3. Add 10 ml of chloroform and 25 ml methylene blue.
4. Rock vigorously for 30 seconds and allow chloroform to separate.
5. Draw off chloroform into second separatory funnel rinsing the delivery tube with chloroform. Repeat three more times.
6. Add 50 ml of wash solution to the second funnel. Shake, allow to separate and draw off chloroform through glass wool into a volumetric flask. Repeat twice adding 10 ml portions of chloroform to the separatory funnel containing the wash water. Rinse glass wool with chloroform.
7. Dilute to mark and make colorimetric comparison using properly calibrated spectrophotometer. Results are reported as ABS with the realization that this is apparent ABS and that the true value may be less than the apparent value obtained by the methylene blue procedure. Of course, if the methylene blue test is substituted for infrared measurement in the final step of the infrared procedure, the value obtained is quite reliable.

It should be noted in any of these procedures the final measurement must be made against a calibration based on known amounts of ABS. Measurements should not be referred to commercial products of unknown composition. Suitable material containing a known percentage of alkyl benzene sulfonate may be obtained from the Association of American Soap and Glycerine Producers, Inc., 295 Madison Avenue, New York 17, New York.

Effect On Water Supplies

Occurrence

First, let us consider the occurrence of ABS in water supplies. A great deal of evidence has been advanced in the literature on specific situations where ABS has been detected in both ground and surface waters. This is not surprising when one remembers that ABS unlike soap resists degradation by waste treatment facilities and by natural forces in rivers, lakes, and subsurface aquifers. In fact logic tells us that surface supplies subject to domestic waste discharges will contain ABS although in many instances dilution will lower the concentration below detection. In order to illustrate this, a series of samples from Michigan surface supplies was examined. Results are listed in Table 1.

Concentration of ABS, mg/l (Methylene Blue Procedure) in Certain Michigan Surface Waters

Table 1

Source	Sample Number 1	2	3	4
Clinton River, Utica	0.5	0.5	0.5	0.6
River Raisin, Blissfield	0.0	0.1	0.2	0.0
River Raisin, Dundee	0.1	0.0	0.1	0.0
Rouge River, Rockford	0.0	0.2	0.0	0.0
Cass River, Frankenmuth	0.0	0.0	0.1	

Samples were taken at approximately weekly intervals during August and September, 1960.

We have on record numerous laboratory reports of ABS concentrations ranging up to several mg/l in private wells. No instances of ABS contamination in municipal wells in Michigan have come to our attention. Municipal wells must meet certain enforced requirements of isolation and construction and are not commonly

in areas with numerous septic tanks and seepage beds. However, with time there is the possibility that ABS may be found in some of these wells.

A survey was conducted in a limited area with individual well and septic tank installations on small lots.[4] Well depths ranged from 12 to 30 feet.

Number of wells sampled	30
Positive for ABS	21
Positive for coliforms	5
Negative for coliforms and ABS	9

All the samples containing coliforms also contained ABS.

ABS occurrence in private wells, particularly in crowded areas, is more common because of the less effective controls on private wells and because private wells are usually associated with septic tanks discharging wastes including ABS which may eventually find its way to the water bearing formation. In another area, rapid housing development utilizing individual wells and septic tanks in a relatively shallow sand aquifer on an impermeable formation has led to numerous instances of ABS contamination. In one case flushing of a toilet resulted in sufficient foam to flow over the bowl onto the bathroom floor.[5]

To sum up, the occurrence of ABS in surface waters should not be a surprise if one first considers other uses being made of that body of water. One may readily predict whether or not samples are more likely to be negative or positive based on prior knowledge of the particular situation.

At present, if conditions are favorable, ABS may be found in ground waters. Depending on the specific sources of ABS and the type of water bearing formation, the length of time necessary before measurable quantities are detected may be a period from months to years or never.

Toxicity and Other Implications

The 1946 United States Public Health Service Drinking Water Standards do not include ABS restrictions. However, it has been proposed that a recommended limit of 0.5 mg/l be included in the next revision. It appears that aesthetic consideration was the prime factor in arriving at this limit when one considers that extensive research has shown that men can tolerate ABS at 100 mg/day for four months and that various animals have been fed diets containing from 0.1 to 1.0 per cent ABS for periods of months without ill effect.[6]

The lethal dose (LD_{50}) that will on the average kill fifty per cent of a group of animals has been reported to be in the range from 0.1 to 0.23 per cent of body weight for various animals. It the 0.1 per cent ratio is applied to a person weighing 100 pounds it would take one liter of 45,000 mg/l ABS to be lethal fifty per cent of the time. Based on present short term knowledge there is no reason to become alarmed from the toxicity standpoint about ABS levels being encountered in some water supplies. However, when one considers that sewage with an ABS content in the 10-20 mg/l range may be the source of the ABS, the public health signficance of ABS as an indicator takes on a different aspect.

In view of the lack of information on chronic effects of continually ingesting small quantities of ABS, our present concern about ABS is largely aesthetic. Frothing will usually occur in the 0.5 to 1.0 mg/l range but frothing is not always a specific indication of ABS.

Taste or odor may be present at any time but again is not specific as it reflects other substances that are associated with the mode of contamination.

Panel tests have shown that odor of purified ABS is rarely detectable below 1000 mg/l and that only sensitive individuals can taste it in water at concentrations as low as 16 mg/l.[7] Other investigators have reported that in 26 ABS contaminated wells, 10 per cent of the owners reported an off-taste at less than 1.0 mg/l while all those whose wells contained 1.5 mg/l or more reported an off taste.[8] Solutions containing from 0.0 to 3.0 mg/l of a standard household detergent were submitted to a panel of 23 members for taste tests. Less than half of the group detected taste at 1.75 mg/l or less. More than half reported taste at 2.0 mg/l and above. However, even at 3.0 mg/l, 9 out of the 23 people did not detect a taste.

Effect on Water Treatment

Research has shown synthetic detergents to have no serious effects on water treatment processes in the concentrations normally encountered[9, 10, 11]. Polyphosphates in some of the forms associated with synthetic detergents have been shown to interfere with coagulation in relatively low concentrations, requiring increased dosages of coagulant. However, in actual plant operation prior conversion of complex phosphates usually sodium tripolyphosphate to orthophosphate in sewage treatment and the counteraction by calcium and magnesium salts have minimized the effect. It should be noted that the orthophosphate may stimulate growth of algae leading to other treatment complications.

Removal of ABS

Removel of ABS in water treatment facilities does not appear to be practical.[9] Chlorine dioxide, aluminum sulfate, ferrous sulfate, settled sediment, precipitated calcium carbonate and clay have been investigated with limited success. Activated carbon is effective but only with high rates of application. For example it has been shown that to reduce 2.0 mg/l of ABS to 0.01 mg/l would require 154 mg/l of activated carbon. A reduction to 0.1 mg/l requires 76 mg/l carbon and reduction to 1.0 mg/l requires 10.5 mg/l carbon.

Removal of ABS in sewage treatment facilities shows promise.[12] Fifty per cent or more is removed in conventional secondary treatment. Removals in the order of 80 per cent may be accomplished in a high-solids, complete-mixing activated sludge system. The addition of a unit to induce frothing of activated sludge effluent with removal and separate disposal of the froth has given total removals from 82 to 93 per cent of ABS from an initial concentration of 10 mg/l ABS in the raw sewage.

Other solutions to the problem of ABS in water may result from research into alternate raw materials and processes for the production of suitable synthetic surface-active agents that do not resist biologic degradation.[13]

Summary and Conclusions

Synthetic detergents have been defined and differentiated from other detergents. The surface-active portion of synthetic detergents is reasonably represented by ABS for which analytical methods are available. The nature of ABS is such that it resists the usual degradation forces and per-

sists in our water supplies. There is no evidence of public health problems directly connected to ingestion of ABS but factual information on chronic effects is lacking. ABS is not amenable to removal in water treatment facilities except by relatively high applications of activated carbon. Efforts are being exerted to develop improved methods of removal in waste treatment facilities and alternate surface-active agents that readily succumb to biologic activity.

References

1. *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes.* APHA, AWWA and FSIWA, New York (10th Ed., 1955).
2. Preview of the Eleventh Edition of Standard Methods. *Journal AWWA,* 52:1074 (1960).
3. Task Group Report. "Determination of Synthetic Detergent Content of Raw-Water Supplies." *Journal AWWA,* 50:1343 (1958).
4. Bandeen, K. C., Central Michigan District Health Department. Unpublished Report, *"Water Analysis Detergent and Coliform Organisms."*
5. Personal Communication-Roger Lewis, Muskegon County Health Department.
6. Technical Advisory Council, Association of American Soap and Glycerine Producers, Inc., "ABS and the Safety of Water Supplies," *Journal AWWA,* 52:786 (1960).
7. Walton, Graham. *"ABS Contamination of Water Resources."* A paper presented May 19, 1960, before the AWWA Annual Conference, Bal Harbour, Florida.
8. Flynn, J. M., Andreoli A. and Guerrera, A. "Study of Synthetic Detergents in Ground Water." *Journal AWWA,* 50:1551 (1958).
9. Vaughn, J. C., Falkenthal, R. F. and Schmidt, R. W. "Effects of Synthetic Detergents on Water Treatment." *Journal AWWA,* 48:30 (1956).
10. Sanford, L. H. and Gates, C. D. "Effects of Synthetic Detergents on Rapid Sand Filter Performance." *Journal AWWA,* 48:45 (1956).
11. Smith, R. S., Cohen, J. M. and Walton, Graham. "Effects of Synthetic Detergents on Water Coagulation." *Journal AWWA,* 48:55 (1956).
12. Weaver P. J. "Review of Detergent Research Program." *Journal WPCF,* 32:288 (1960).
13. Livingstone, F. C. "Research in Water Pollution." *Water and Sewage Works,* 107:89 (March 1960).

Repeated use of Municipal Water is Dow's Goal

The likelihood that an activated carbon holds the key to solution of some of the nation's water shortage problems is being investigated by Dow Industrial Service Division of The Dow Chemical Company.

The division's consulting laboratory has launched a one-year research program, in which various activated carbons will be evaluated as possible agents in the purification of municipal waste water.

The work is being done under a contract awarded by the U.S. Public Health Service, as part of its Advanced Waste Treatment Research Program.

Frank Middleton, of the USPHS' Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio, is the project officer.

The researchers seek to establish feasible methods of treating secondary sewage treatment plant effluents so that waste water can be used again and again. USPHS describes the importance of the research this way:

"In the face of a naturally fixed water supply, the growing needs of an expanding population and industrial complex will require that water be used over and over.

"Re-use of water is now a reality in some areas; eventually, re-use will become an accepted and necessary practice in most densely populated areas of this country.

"It has long been recognized that waste waters must be returned to the water courses from which they were taken in such condition that subsequent water use is not jeopardized. The development of satisfactory techniques for doing this represents a major, challenging research problem."

According to the USPHS, studies have indicated that various water supplies are undergoing important changes in composition.

Ever-increasing amounts of biologically undegradeable organic materials are finding their way into waterways. Such contaminants are not removed by modern water treatment methods. Even the best available methods of detecting and identifying them are only partly effective.

For those reasons, research under the Advanced Waste Treatment Research Program will investigate physical-chemical principles applicable to their removal.

"Of the various techniques which have been suggested as applicable," USPHS points out, "adsorption and oxidation are the only ones which have enjoyed some measure of practical utilization."

Activated carbons, for instance, have been used in water treatment plans for removal of offensive odors and tastes. But their use in municipal waste treatment has been relatively neglected.

Nevertheless, their technical adequacy is relatively certain and will not seriously concern the consulting lab; the real problem at hand involves the economic feasibility of their use.

The reason which pointed the direction of the research is this:

Since ultimate disposal of the collected waste is of great importance, a technique in which waste materials are destroyed by oxidation has inherent advantage.

It seems reasonable, therefore, that utilization of activated carbon, a proven efficient collector for organic wastes, coupled with oxidation in situ, provides an approach of some promise.

Possibly four to six types of activated carbons will be studied for their ability to remove gross contamination.

As Middleton says:

"Because specific pollutional manifestations of most specific contaminants are as yet undetermined, we must operate under the hypothesis that reduction of gross contaminant concentration is the best measure of removal efficiency."

The other important phase of the research will be completely exploratory in nature. Its prime objective will be to determine the feasibility of the oxidation of adsorbed materials in place.

Various chemical oxidizing agents will be evaluated for their ability to efficiently destroy the waste materials adsorbed by activated carbon, and at the same time provide a satisfactory degree of regeneration.

Consideration must be given, at the same time, to the possible contamination of water which is processed through the regenerated carbon.

The research will be conducted by sanitary engineer Robert Moore Smith in the DIS consulting laboratory in Midland, Michigan. Thomas J. Powers, consulting director of DIS, who is attached to division headquarters in Cleveland, Ohio, will direct the project.

The Destruction of Alkyl Benzene Sulphonates in Sewage Treatment Processes

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Dept. of Scientific & Industrial Research,
Water Pollution Research Lab.,
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■ IN THE UNITED KINGDOM, the use of synthetic detergents on a large scale may be said to have begun about 1949. Table 1 illustrates the rapid rate of growth in the period 1949-1955, followed by a comparatively slow increase. The greater proportion of this surface-active material is used in the home and is therefore discharged to sewers without restriction. Most of it is in the form of packaged detergent powders based on alkyl benzene sulphonates. Figures given in Table 2 illustrate the relatively small proportion used in the form of liquid detergents in 1958. Moreover, most of these liquid detergents were based on biologically attackable or "soft" surface-active materials. The bulk of the surface-active material entering the sewers, therefore, is derived from packaged washing powders in which the active ingredients, in 1958, was sodium tetrapropylene benzene sulphonate (sodium Dobane PT suphonate).

It soon became apparent that the new synthetic detergents were not completely removed at sewage treatment works. In particular, the large-scale introduction of these materials in a district was often followed by complaints of excessive foaming at the local sewage works and in the rivers to which their effluents were discharged. In addition, it was claimed at some sewage works the efficiency of treatment had been reduced and consequently, the quality of the final effluent had deteriorated. The persistence of the surface-active material was also illustrated by its appearance in some river-derived water supplies.

In view of these and similar observations, an official Committee was set up in 1953 to consider generally the effects of the increasing use of synthetic detergents on public health. The Committee, known as the Jephcott Committee, after its Chairman, Sir Harry Jephcott, issued its final report in 1956[1]. This contained a number of conclusions and recommendations. One stated that manufacturers should investigate the possibility of producing efficient washing products based on materials which would be eliminated and which would not cause foaming during sewage treatment.

About the same time, a number of aspects of pollution by synthetic detergents were studied at the Water Pollution Research Laboratory. Among other findings the following effects were established:

a. In a laboratory-scale activated-sludge plant introduction of sufficient packaged detergent to give a concentration of 10 ppm, as Manoxol O.T., in the sewage had no detrimental effect on the quality of the effluent provided that aeration was adequate. However, the dissolved oxygen content of the mixed liquor fell from 5.2 to 3.3 ppm[3], representing a reduction in the absorption coefficient for oxygen in mixed liquor of about 37 per cent. When the rate of aeration was reduced to a level at which nitrification was incomplete, introduction of the same concentration of detergent resulted in an increase in the ammonia concentration of the effluent with a simultaneous reduction in the concentration of oxidized nitrogen. To restore the efficiency of the plant to its original level, it was found necessary to increase the flow of air by 2-3 times. These experiments confirmed to some extent the complaints of reduced efficiency at large-scale sewage treatment works.

b. A solution of packaged synthetic detergents equivalent to 3 ppm as Manoxol OT in clean well-oxygenated water produced about 50 per cent mortality among rainbow trout in about 12 weeks[4]. When the concentration of dissolved oxygen was reduced to near lethal levels, the same concentration of detergent rendered the fish more susceptible to lack of oxygen. Similar concentrations of synthetic detergent remaining after biological treatment of sewage were much less toxic, and residues equivalent to 3 ppm Manoxol OT had no detectable effect on susceptibility to oxygen in this country surface-active materials in sewage effluents were unlikely to represent any serious danger to fish.

*All concentrations of surface-active material referred to in this paper were determined by the method of Longwell & Maniece[2] and are expressed in terms of Manoxol O.T. (sodium dioctyl monosulphosuccinate).

Table 1
Consumption of Synthetic Surface-Active Materials In The United Kingdom

Year	Thousands of Long Tons Domestic	Industrial	Total
1949	10.5	2.5	13.0
1950	12.5	2.7	15.2
1951	14.0	3.8	17.8
1952	21.0	5.2	26.2
1953	29.0	6.0	35.0
1954	33.0	6.0	39.0
1955	34.0	6.5	40.5
1956	34.5	6.5	41.0
1957	34.1	6.9	41.0
1958	35.0	7.3	42.3
1959	37.5	7.4	44.9

Preliminary Testing of "Soft" Alkyl Benzene Sulphonate

By 1958 a new type of alkyl benzene sulphonate, which seemed to meet the requirements of the Jephcott Committee, had been produced by the manufacturers and was made available in small quantities for testing. Preliminary tests by the London Metropolitan Water Board and by the Laboratory of the Government Chemist confirmed that the new material, sodium Dobane JN sulphonate, subsequently referred to as "soft", was more readily removed by biological action than the original, "hard" material. A comparison of the rates of removal of the old and new materials when incubated with river water is shown in Fig. 1.

Examination of the infrared absorption spectra of the two materials at the Laboratory of the Government Chemist suggested the "soft" material had a less branched carbon chain and that it contained substances such as those shown at c and d in Fig. 2. Typical constituents of the "hard" material are shown as a and b in the same figure.

In view of the promising results obtained in the preliminary tests, the Standing Technical Committee on Synthetic Detergents, the successor to the Jephcott Committee, requested the Water Pollution Research Laboratory to carry out a more extensive investigation to determine the behavior of the new material in sewage treatment processes.

For this purpose, equipment (Fig. 3) was set up to reproduce in the laboratory sewage treatment by activated sludge and biological filtration. Since all sewage available in this country contains surface-active material, arrangements were also made for the production at the laboratory of a detergent-free sewage at the rate of several hundred gallons per week. Comparative tests were then carried out in which sewage containing either the "hard" or the "soft" detergent was treated in replicate units. Detergents used in these experiments were supplied by the manufacturers in the form of packaged washing powders. These were added to the detergent-free sewage in the proportions necessary to give a concentration of 13 ppm as Manoxol OT, an average figure for surface-active material in sewage in the U.K.

Results obtained at equilibrium summarized in Table 3, illustrated the greater degree of removal of "soft" material in sewage-treatment processes and suggested that, if this material were to replace completely the "hard" material, the concentration of residual surface-active material in sewage effluents and rivers would fall to about one-quarter of the present values, provided, of course, the degree of removal achieved in the laboratory could be reproduced on the large-scale. These experiments have been described in greater detail elsewhere[5].

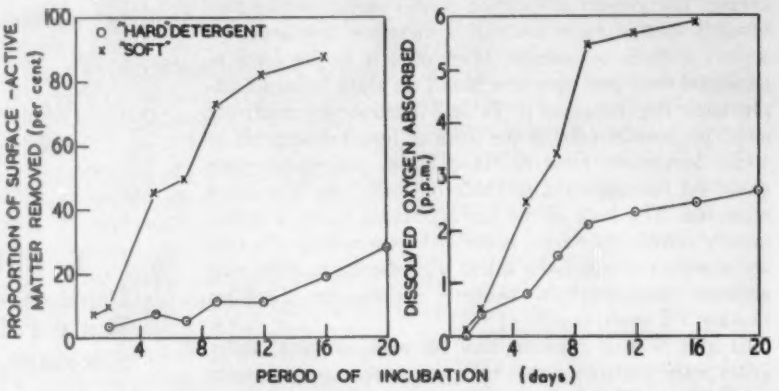

o "HARD" DETERGENT
x "SOFT"
PROPORTION OF SURFACE-ACTIVE MATTER REMOVED (per cent)
DISSOLVED OXYGEN ABSORBED (p.p.m.)
PERIOD OF INCUBATION (days)

Fig. 1. BREAKDOWN OF surface-active materials on incubation at 20°C with an oxygenated river water. Initial concentration about 8 ppm, as Manoxol OT.

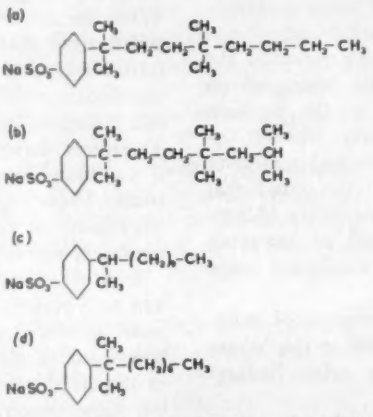


Fig. 2. THE ORIGINAL "HARD" sodium tetrapropylene benzene sulphonate, sodium Dobane PT sulphonate, consists of compounds such as (a) and (b). The "soft" material, sodium Dobane JN sulphonate, contains compounds with structures such as (c) with perhaps some of type (d).

Table 2
Estimated Consumption of Liquid Detergents In The United Kingdom During 1958

	Thousands of Long Tons
Primary alkyl sulphates	0.48
Secondary alkyl sulphates	1.52
Alkyl benzene sulphonates	
biologically "hard"	0.51
biologically "soft"	0.71
Non-ionic	0.98
Total active matter	4.2

The resistance to further oxidation of the residual surface-active material derived from the new product was determined by aerating samples of effluent in open vessels for periods up to 20 days. Although some further oxidation occurred it appeared that some 0.5 ppm (4 per cent) was resistant to further attack. No further oxidation occurred when effluents derived from sewage containing the old material were aerated under the same conditions.

During this work the foaming properties of the various effluents were determined using an arbitrary test[6] in which the height of foam produced under standard conditions of aeration was measured. Effluent from the treatment of sewage containing the new detergent contained comparatively low concentrations of residual surface-active material and produced amounts of foam which were not significantly greater than those produced from the detergent-free ef-

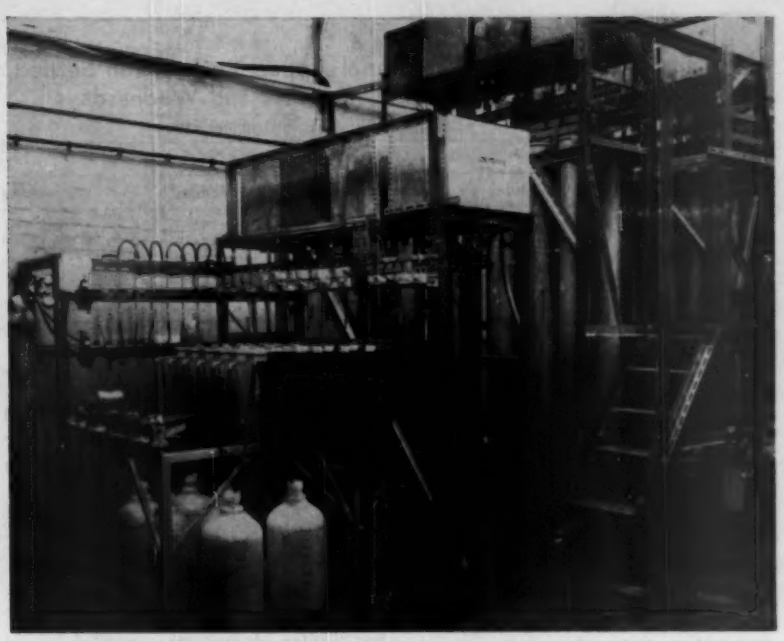


Fig. 3. APPARATUS USED in tests on the removal of detergents from sewage. Activated-sludge units are on the left and percolating filters on the right.

fluent. Effluents from sewage containing the "hard" detergent contained higher concentrations of residual surface-active material and gave considerably greater amounts of foam.

Subsidiary experiments showed that while, weight for weight, the effect of the "soft" detergent on oxygen transfer was similar to that of the old, the greater degree of removal during sewage treatment resulted in a smaller adverse effect on the overall process efficiency. Toxicity tests on effluents from sewage containing the "soft" detergent showed these were virtually non-toxic to rainbow trout.

It should be added that the sewage-treatment processes were operated under favorable conditions and were giving highly nitrified effluents. The removal of synthetic detergents under conditions of overloading and uneven loading is still being investigated.

The results were considered sufficiently promising to justify the use of the new "soft" material on a larger scale, and the Committee decided to take advantage of an offer by the manufacturers to produce the new materials in the quantities required for a large-scale experiment.

Large-Scale Trials—the Luton Experiment

The aim of this experiment was to replace a large proportion of the synthetic detergent used in a typical town by the new material, and, by studying the resulting changes in the concentration of detergent in the sewage and final effluent, to ascertain whether the results of the laboratory tests would be repeated under full scale conditions. For various reasons, Luton, an industrial town having a population of 120,000, was chosen for the experiment which was begun in the autumn of 1958. The new material was used by the three major manufacturers in the formulation of their normal brands of washing powders which were supplied to the town through the usual retail channels. It was decided initially that the fact that this experiment was being conducted should not be disclosed, the object being to prevent changes in the patterns of purchase and use of detergents by the general public. Information about the experiment was first made public in reply to a question in Parliament on 28th July 1959.

Sewage from Luton undergoes comprehensive treatment by primary sedimentation, a high-rate activated sludge process, biological filtration, and secondary sedimentation, followed by microstraining or sand filtration before discharge to the River Lee. Further downstream the river serves as a source of about 15 per cent of the London water supply.

Before the experiment began, assessments were made of the amounts of surface-active material appearing each day in settled sewage, and leaving the works in the final effluent. For this purpose automatic samplers were set up to take samples at 2-hour intervals throughout the 24 hours. In view of sampling difficulties, no attempt was made to assess the amounts of surface-active material entering the works in crude sewage. As time was limited, attention was concentrated on the three days of the week, Monday, Tuesday,

Table 3
Removal of "hard" and "soft" Alkyl Benzene Sulphonates (ABS) During Biological Treatment of Sewage In The Laboratory

	Initial Concentration 13 ppm (as Manoxol OT)			
	Biological Filtration*		Activated-Sludge Process†	
ABS	Percentage removed	Residual Concentration (ppm)	Percentage removed	Residual concentration (ppm)
Hard	67	4.3	69	4.0
Soft	94	0.9	94	0.9

*Rate of application 1.16 million U.S. gal/acre day
†Retention period 6 hr
Suspended solids 3000 ppm

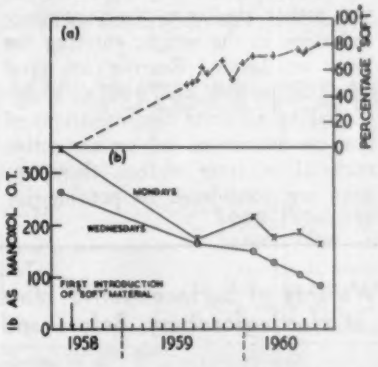


Fig. 4. PROGRESS OF the Luton Experiment. (a) Percentage "soft" in detergent content of settled sewage. (b) Weights of surface-active material discharged daily in final effluent.

and Wednesday, on which it was thought the worst effluents would be produced. During this period, June and July 1958, exceptionally wet weather was experienced and only on 5 occasions were 24-hour sampling runs completed without interference by rain. Satisfactory agreement was obtained between duplicate sets of results for Monday and for Wednesday.

Introduction of the new material was begun early in August 1958. An account of the experience of the manufacturers in making this change-over has been given by Squire[8]. As replacement of the "hard" by the "soft" material proceeded, samples of the settled sewage were examined by the Laboratory of the Government Chemist using infrared spectroscopy to distinguish the two types of material[9]. Typical results are shown in Fig. 4.

Measurements of the weights of surface-active material in settled sewage and in filter effluent on various occasions during the experiment are shown in Table 4. An interesting feature of these results is the marked decrease in the weight appearing in the settled sewage. This could not be accounted for by a reduction in sales and is attributed to losses by decomposition of the new material in the sewers and primary sedimentation tanks. These losses are additional to the losses of surface-active material which are known to occur during primary sedimentation. Decomposition was also found to occur when Luton sewage, containing a proportion of the new material, was allowed to stand in the bottles of the automatic samplers overnight; losses of up to 20 per cent were observed. This decomposition was prevented by adding to each sample bottle before use sufficient mercuric chloride solution to give a concentration of 10 ppm $HgCl_2$ in the sample.

Table 4 also illustrates the decrease in the weight of surface-active material discharged in the final effluent on a given day as the replacement of "hard" by "soft" material proceeded. Fig. 4 shows how these weights have decreased as the proportion of "soft" to "hard" detergent in the settled sewage has increased.

Table 4
Weights of Surface-Active Material Appearing In Luton Settled Sewage and Final Effluent On Mondays and Wednesdays

	Settled Sewage		Final Effluent	
	lb as Manoxol OT			
Date	Monday	Wednesday	Monday	Wednesday
June-July 1958*	1120	746	346	262
Aug. 10-12 1959	766	693	174	165
Feb. 1-3 1960	778	601	217	148
April 4-6	844	611	177	128
June 13-15	792	514	186	104
August 15-17	708	402	165	82.5

*Mean of two sets of results

Effect of the New Detergent on the River Lee

For several months before the introduction of the new detergent at Luton, and throughout the experiment photographs have been taken regularly at two places on the River Lee at which foam is generally present, namely at Wheathampstead Mill and at Lemsford Mill. Samples of river water have been taken at the same times for determination of surface active material.

During March-July 1959 the amount of foam shown in photographs of the river at Lemsford was appreciably less than the amount at the same times in the previous year, as judged by a panel of observers to whom the photographs were shown in a random and undisclosed order. This apparent improvement, however, was not subsequently maintained and there appeared to be little correlation with the concentrations of surface-active material determined by analysis.

Some estimates of the amounts of surface-active material passing down the River Lee at Hertingfordbury, some 15 miles below the Luton effluent outfall, during the months of April to September in 1958 and 1959[10] are given in Table 5. The was rather similar to the percentage reduction in the weight entering the river at Luton. Bearing in mind sampling errors and the difficulty of making accurate determinations of low concentrations of surface-active material in river waters, these results are considered to provide independent evidence of the reduction in the detergent content of the River Lee as a consequence of the Luton experiment.

Conclusions

On the basis of the laboratory experiments, it was estimated that if a similar degree of removal could be achieved on the large scale, the replacement of all the surface-active material used in Luton by the new "soft" material would result in a reduction in the weight of detergent residues discharged to the River Lee to about a quarter of the former value. This result has not yet been achieved, partly because of the less efficient removal of surface-active material at the sewage works as compared with removal in laboratory plant and partly because the original "hard" material has not yet been completely replaced by "soft". This incomplete replacement may be attributed to the introduction of "hard" material in forms other than the packaged products of the major manufacturers, for example, scouring powders, and to the time required for the using up of household stocks.

Since September 1959 detergents containing the new "soft" material have been supplied to a much larger area in the south of England. The effect of this will be to reduce the amount of "hard" material reaching the Luton area and gradually to in-

Table 5
Weights of Surface-Active Materials Passing Down The River Lee at Hertingfordbury, Before and During the "Luton Experiment"

	lb as Manoxol OT per day						
Year	April	May	June	July	August	September	Mean
1958	318	258	213	209	197	216	235
1959	244	151	164	133	141	134	161
Percentage reduction	23	41	23	36	28	38	31

crease the probability of a more decisive conclusion to the Luton experiment.

Finally, it should perhaps be pointed out that the "soft" material studied in these tests is only one of many substances which have satisfactory properties as detergents and which are broken down in sewage treatment processes. The Luton experiment, though not yet completed, already indicates it may be possible to manufacture on the national scale detergents which are acceptable to the housewife and which minimize the problems in sewage treatment and water supply which resulted from the introduction of the original synthetic detergents.

Acknowledgments

This paper summarizes briefly the work of many members of the staffs of the manufacturers of synthetic detergents, the Metropolitan Water Board, the Laboratory of the Government Chemist, and the Water Pollution Research Laboratory. Facilities for sampling and photography were provided by the Borough of Luton, Harpenden Urban District Council, and the Lee Conservancy.

Much of the work described in this paper was carried out on behalf of the Standing Technical Committee on Synthetic Detergents. The paper is published by permission of the Department of Scientific and Industrial Research.

References

1. Ministry of Housing and Local Government. Report of the Committee on Synthetic Detergents. H. M. Stationery Office, London (1956).
2. Longwell, J., and Maniece, W. D. Determination of Anionic Detergents in Sewage Effluent and River Waters. *Analyst*, 80: 167 (1955).
3. Downing, A. L., and Scragg, L. J. The Effect of Synthetic Detergents on the Rate of Aeration in Diffused Air, Activated Sludge Plants *Water & Waste Treatm. J.*, 7:102 (1958).
4. Herbert, D. W. M., Elkins, G. H. J., Mann, H. T., and Hemens, J. Toxicity of Synthetic Detergents to Rainbow Trout. *Water & Sewage Treatm. J.*, 6:394 (1957).
5. Truesdale, G. A., Jones, K., and Vandyke, K. G. Removal of Synthetic Detergents in Sewage-Treatment Processes. *Water & Waste Treatm. J.*, 7:441. (1959).
6. Truesdale, G. A. Foaming of Liquids Containing Synthetic Detergents. *Water & Waste Treatm. J.*, 7:108. (1958).
7. Eden, G. E., and Melbourne, K. V. A. Battery-Operated Water Sampler. *Chem. & Industr.*, 220 (1959).
8. Squire, G. V. V. The Manufacturers' Part in the Luton Experiment. Paper No. 2 in a Symposium "Progress towards the solution of the synthetic detergents problem" presented at the Annual Conference of the Institute of Sewage Purification, Scarborough (1960).
9. Bolton, H. L., and Cooper, P. J. Analytical problems in the Luton Experiment. Paper No. 4 in the same Symposium.
10. Ministry of Housing and Local Government. Third Progress Report of the Standing Technical Committee on Synthetic Detergents. H. M. Stationary Office, London (1960).

Erie County Water Authority Reports Progress

The Erie County Water Authority report for 1960 reveals the progress made by the Authority on its long-range water supply plan. The development program is nearing completion, the report says, and when completed it will service the fast-growing population with over one hundred miles of distribution mains, new pumping stations and local-area storage and booster facilities. From 1960 to 1970 the Authority plans to expend between 4.5 and 6.5 million dollars for capital improvements. It will become the only agency, public or private, operating two complete water treatment plants in the county. These are only a part of the nine section plan for providing water for the future.

By December 31, 1960 the total of services by the Authority had increased 39 per cent in a seven year period to 44,173. The increase in transmission and distribution system had grown 36 per cent to 537 miles of mains in sizes up to 42-in in diameter. The number of fire hydrants owned and operated by the Authority had grown to 2,561, an increase of 31 per cent over the seven years. The distribution system storage has increased by 29 per cent to a 22,100,000 gal capacity. The primary pumping and booster capacity now stands at 278 million gal capacity. Over $19 million has been spent to improve and add to the water system in the seven years.

Toledo Annual Water Report

The city of Toledo, Ohio, reports total revenues for the year amounted to over 4 million dollars and reached a new high in customers with 107,040 accounts. Due to annexations the net number of customers inside the city increased from 81,699 to 83,863 while accounts increased 1,710 during the year. No unusual incidents were reported which may have hampered the city water system.

W&SW FUTURE FEATURES . . .

Manuscripts Scheduled for the Next Few Issues of W&SW

Treatment Plant at Washington, D. C. Prison

E. E. Halmos, Jr.
Construction Editor
The problems and details of the construction of a treatment plant within the grounds of a prison.

Water Utility Distribution Loss—Part 1

Dale Smelser
Knoxville, Tenn.
This is the first of a four part series on the studies of water quantity accounting.

Long Pipe Sections Bolted for Underwater Sewer Line

Anthony N. Mavroudis
Burson-Marstellor Associates, New York
A short story of the crossing of the Genessee River to extend sewage facilities.

Coliform Distribution in Central Texas Bays

C. H. Oppenheimer, N. B. Travis and H. W. Woodfin
Institute of Marine Science
The University of Texas
A detailed Research Progress Report dealing with salinity, pH and turbidity in the Texas Bays and the effects of sewage upon them.

Liquid Alum Tank Linings

by T. B. CORLETT, JR.
Water Works Engineer
C. M. BACH, Supt. of
Water Treatment
Fridley Softening Plant
Minneapolis, Minn.

■ DURING JANUARY 1957, the Minneapolis Water Department started investigating the advantages of liquid alum over dry alum. Inasmuch as there was a definite saving, as far as cost was concerned between the price of dry alum and liquid alum ($3.34 per ton on dry basis), and because there would also be a definite saving in labor costs, it was decided to make provisions for using liquid alum at each of the three plants: the Softening Plant, the Fridley Filtration Plant, and the Columbia Heights Filtration Plant.

The Columbia Heights Filtration Plant does not have any railroad siding. Therefore, all bulk chemicals have to be delivered to one of the other plants to be unloaded and then rehandled and hauled to the Columbia Heights Filtration Plant by truck. This involves extra expenses that would be eliminated if liquid alum were used. At the other plants, labor costs could be reduced and maintenance costs on the pneumatic conveyor equipment practically eliminated.

Because of the low pH (2-3) of a 50 per cent alum solution, any tank used for its storage must be lined with a non-corrosive material. The alum producers recommended lining the tanks for storage of liquid alum with sheet lead, the installed cost of which would come to approximately $5.00 per square foot.

It was difficult, and yet it seemed that to obtain any definite information on any other lining material, at this stage of our National technology there must be some type of coating available that would serve the purpose and still be much cheaper than lead. As a result, a research project was started to test linings under actual operating conditions.

Fig. 1. A CONCRETE TANK FLOOR deeply pitted from being used to dissolve dry alum in water.

Operating Conditions

First, a concrete tank, 14 in. x 17 in. x 17 in. inside dimensions, was constructed with the idea that it would act as a holding tank for liquid alum in which concrete brick, coated with various expermental linings, could be placed.

The sides of the experimental tank were left rough with numerous pits in order to simulate the three concrete tanks at the Columbia Heights Filtration Plant. These tanks were located in the basement of the plant and had been used years ago to dissolve dry alum in water, the resulting solution being added to the water as a coagulant instead of the dry alum itself.

As a result of heavy use of these concrete tanks for this purpose, the sides and floor were deeply pitted (Fig 1). This condition led to the attempt to find a material which would cover the tanks in their pitted condition, without having to mortar smooth the rough surface.

In order to accelerate the action of the liquid alum on the different materials and thereby demonstrate an extended life expectancy from whatever material that proved satisfactory, the temperature of the liquid alum solution was maintained at 150° F by means of a thermostatically controlled heating element. An agitator was located in the center of the tank to rapidly disperse the heat from the heating unit and continuously agitate the liquid alum (Fig. 2).

Liquid alum, as received, may vary in temperature from 100 to 120° F, but, on being discharged into the storage tank, cools rather rapidly either by radiation or by being diluted by liquid alum already present in the storage tank. It was decided that a lining that would hold up at a temperature of 150° F for a specific period would have an extended life at much lower average temperatures.

A number of companies that manufactured coatings they thought would withstand liquid alum at a temperature of 150° F submitted samples for testing. The Water Department furnished the concrete brick and most of the companies coated the bricks at their own plants. Whenever the Department coated the brick, they followed the manufacturers instructions implicity, though it was considered preferable that the manufac-

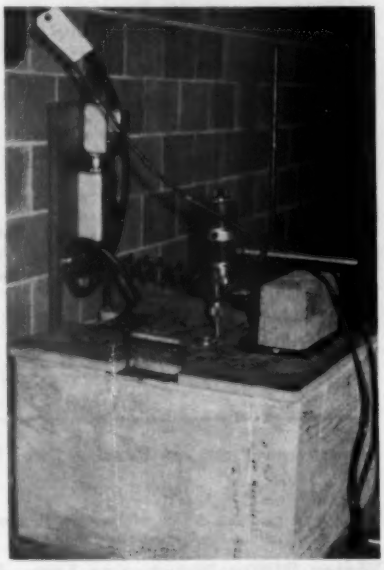


Fig. 2. AN AGITATOR located in the center of a tank to rapidly disperse the heat from the heating unit and agitate the liquid alum.

Fig. 3. CONCRETE EXPERIMENTAL tank coated with two coats of an epoxy resin.

turer do the coating to insure it was put on according to their specifications.

The concrete experimental tank was coated with two coats of an epoxy resin (Fig. 3). On December, 4, 1957 the coated bricks were placed in the tank with liquid alum.

The bricks and the tank were inspected every two weeks or oftener so those bricks whose lining failed could be removed before the liquid alum could attack them and weaken the solution. Indications of a break in the coating or a defective coating was indicated by bubbles in the liquid above the brick.

Tests were run on the liquid alum periodically to make sure its strength was maintained. As the water was evaporated from this solution, because of the high temperature, distilled water was added every twelve hours to keep the volume of liquid constant.

Many bricks were removed from the solution a few minutes after submergence, because of immediate failure of the coating. Others remained in the tank for varying times up to 18 months.

The tank lining failed after a period of five months. The inside of the tank was sandblasted and coated with four coats of chemically resistant white vinyl coating. This vinyl coating remained intact and was in excellent condition at the end of fifteen months, the extent of the experimentation.

As a result of the experimental work, it was decided to coat one tank at the Columbia Heights Plant with a paint called Glid-Iron.* This product had remained intact for four months and appeared in excellent condition. The material was ordered and the brick removed from the test tank. The following morning this brick had developed cracks at its edges.

This material apparently could not stand the changes in temperature from 150° to room temperature, and it was therefore decided not to use this material.

Instead, the vinyl coating that had been used to coat the experimental tank was chosen. This material had remained in excellent condition for a period of ten months, and it was felt that because of the cost of application it would be much cheaper in the long run to use this material than to use lead.

The vinyl coating could be sprayed on in coats of 1½ mils thickness per application. After sandblasting the walls and floor, the walls and floor of one tank (13 ft x 13 ft x 13 ft) were coated with five coats of this material to give a thickness of 7½ mils. Any pinholes remaining after the second coat were filled with a mixture of vinyl and whiting. The drying time between coats was two hours. The walls were coated first and then a suspended scaffold was used to apply the coatings to the floor. Because of the extreme roughness of the surfaces, it was difficult to do a good job of covering all the surfaces.

In May of 1959 the first liquid alum was added to this tank. In August the tank was emptied and inspected. At the bottom of one wall on the floor a three foot by six inch strip of the vinyl had come loose. There was also one spot on the wall, the size of a silver dollar, where the vinyl had been removed. On investigation the reason was found that the floor of the tank was porous and thin because of the years it had been used to dissolve dry alum in water, and groundwater had seeped up through the floor at this one spot.

A six inch reinforced concrete floor was then poured on top of the old floor and, after drying, it was coated with five coats of vinyl. The spot on the wall was covered and the tank put back into service.

It was decided that a much better job could be done on the second tank if after sandblasting a concrete floor was poured and the walls of the tank were mortared smooth. This was done and the second tank was coated with five coats of vinyl the same as the first. This tank was put into operation in August of 1959.

After a period of one year of service, both tanks are still in excellent condition with no indication of any failure of the coating.

The concrete tank at the Fridley Filtration Plant is located on the second floor of the Plant. This tank is constructed in the shape of a cube with a hopper bottom. It had been used as an activated carbon storage tank. The capacity and surface area are given in Table 1.

This tank was coated with a product called Duro-crete*, an epoxy resin with a silica binder. A binder, hardener and aggregate were mixed and troweled onto the surface of the tank. The resulting thickness of the coat was from ¼ to ½ inch. This material is difficult to apply to a wall surface and after it is mixed has to be applied within a 60 minute period or it gets too hard. It must be applied in small quantities and worked into the previously troweled surface.

The labor cost per square foot for the application of this product was much greater than the cost of the

*Product of Glidden Paint Company, Minneapolis, Minn.

*Product of Electro Chemical Engineering and Manufacturing Company, Emmons, Pa.

Table 1

Consolidated Cost Data

Location of Tank	Lining Material	Tank Capacity cu. ft.	Tank area not including roof sq. ft.	Total Cost	Cost per sq. ft.
Columbia Heights	Vinyl	2197	945	$1461.00	$1.55
Fridley Filter Plant	Duro-crete	1930	1075	2702.00	2.51
Softening Plant	Edgco #3	6950	2031	3081.00	1.51*

*Cost of installing 10 inch floor not included ($2400.00)

Table 2

Softening Plant

1. Cost of Materials	
(a) 185 gallons Edgco Neoprene Brush Coat #3 with accelerator at $10.50 gal. in 50 gallon drums or $11.00 per gal. in 5 gallon pails	$1960.00
2. Labor Cost 344 Man hours at $3.26	1121.44
Total Cost	$3081.44

Table 3

Columbia Heights Filtration Plant

1. Cost of Materials	
30 Bags Sand at .70	$ 21.00
10 Bags Cement at 1.17	11.70
30 Gallons Vonyl Paint at 4.95	148.50
30 Gallons Thinner at 1.34	40.20
Installation of 6 inch floor	310.00
	$ 531.40
2. Labor Cost	
Sandblasting, 168 man hours at 2.60	$ 436.80
Mortaring Walls, 48 man hours at 3.75	180.00
Vinyl applications, 96 man hours at 3.26	312.06
	$ 929.76
Total	$1461.16

other products (Table 4). Although the overall cost per square foot for this product was higher than the other products, it will hold up better and give less trouble than the other products. This tank was placed in service on October 21, 1959.

A large overhead concrete tank at the Softening Plant was lined with seven coats of Edgco Neoprene Brush Coat #3.* This tank had previously been used for storage of bulk lime. Before using it for storage of liquid alum, a ten inch reinforced concrete floor had to be poured in order to decrease the angle of slope near the walls. This minimized cracking at the wall-floor joint. This product can be applied by brush, roller or spray. On this job, rollers were used and the coating applied from a scaffold suspended from the ceiling. This tank was 52 feet long and had two, 2 ft x 3 ft, openings, one at each end of the tank.

*Product of K. A. Steel Chemicals Inc., Chicago, Ill.

The Edgco has a volatile solvent that is toxic; therefore care has to be exercised in its use to make sure proper ventilation is available for the tank. This was one of the most difficult points to provide in the application of this product. Two air hoses were provided for the tank and a suction fan was installed at one of the openings. The painters found it difficult to remain in the tank for extended periods of time.

One coat of neoprene was applied each day. Each coat had to be applied to the previous coat while the coat was still tacky. If the coat sets too hard over night the surface then has to be sprayed with the solvent before the next coat is applied.

Inspection of the surface after the final coat had dried and the scaffold removed from the tank showed a number of small spots along the bottom of the wall not covered satisfactorily. It was difficult to apply these coats from a suspended scaffold and to cover thoroughly the area below the scaffold, especially since the walls had numerous small depressions throughout. The small openings that had not been covered properly were filled with putty.

Liquid alum was placed in this tank on February 2, 1960. On inspection of this tank after three months of service there was one spot that had to be filled with putty. All of these coatings are in excellent shape at the present time. The two tanks at Columbia Heights Filtration Plant and the tank at the Fridley Filtration Plant have been in service for one year. The tank at the Softening Plant has been in service over eight months.

Table 4

Fridley Filtration Plant

1. Cost of materials	
54 Cartons Duro-Crete at 21.75	$1174.58
8 Gallons Nitro-Dur 100 Thinner at 8.50	68.00
	$1242.50
2. Labor Cost	
Application, 320 man hours at 3.26	$1043.20
Application, 160 man hours at 2.60	416.00
	$1459.20
Total	$2701.70

It is too early to predict the life of these coatings but, from the standpoint of cost, the vinyl coating looks the most promising. If only the cost of material and the application of the coating is considered the vinyl cost is $0.53 per sq ft. The additional cost of $1.02, as shown by Table 1, includes sandblasting, a reinforced concrete floor and covering the walls with a layer of mortar to make them smooth. To give the best results for the application of vinyl, it is recommended the tank walls and floor be smooth. Under these conditions the cost is reasonable and the coating can be expected to last for years.

Water Inventory of the Ohio Brush, Eagle, Straight and Whiteoak Creek Basins

Development of the water resources in the 982-square-mile Ohio Brush-Whiteoak watersheds in the southern part of the state will require organization of a conservancy district, according to a Water Inventory report just released by the Division of Water, Ohio Department of Natural Resources.

Although present water resources are more than adequate, the report reads, the potential resources for the future will require development by wells, reservoirs and pipelines.

To accomplish the basin-wide planning and coordination of projects, the formation of a conservancy district and assignment of a watershed engineer is advisable.

The report urges that engineering studies and orderly planning should start now.

The area is under growing recreation pressure from all sides, the report states, especially from Cincinnati. Several reservoir sites could also be valuable for water supply and flood control which increases the importance of multi-purpose considerations.

Recommended reading in May-June issue of INDUSTRIAL WATER & WASTES:

Design Standards for Multiple Chamber Incinerators, Part I

Foam Separation

Recovery and Treatment of Metal-Finishing Wastes by Ion Exchange, Part I

Pollution Control Program

New Processes and Plants for Treatment of Effluent and Water

Investigation of Methods of Stream Improvement

Asuncion, Paraguay
- *First Year*

by RADER AND ASSOCIATES
Engineers and Architects
Miami, Florida

■ Way down in Asuncion, Paraguay, people are talking about *el agua corriente*—running water—which was introduced to the 423-year old capital city just a year ago.

A $12 million municipal water supply, treatment and distribution system, one of the most modern in the world, was formally dedicated last August 15, coinciding with the annual celebration of the city's founding by the Spaniards in 1537.

Rader and Associates of Miami, Florida, designed the system, which includes a network of 258 kilometers of pipe, a treatment plant, clear well reservoir, main pumping station on the bank of the huge Rio Paraguay, plus supplementary reservoirs and pumping stations for varying levels of the city. The Miami firm also supervised construction by Kaiser Engineers International, Inc., and has assumed responsibility for operation for a period of two years, along with the task of training local technicians to take over.

Asuncion had been striving since the turn of the century to work out financing for a water system and until last year was the only Western Hemisphere capital without one. A study and feasibility report completed in 1955 were the basis for loans granted by the Export-Import Bank and the Development Loan Fund.

At the end of 10 months' operation, 9,300 connections had been made to the system, which presently is geared to supply 20,000 connections. During last May the system averaged pumping 3.23 million gallons per day. Right now, connections are being made at the rate of 150 to 300 per month. A series of street fountains has been installed for the benefit of those who didn't anticipate home connections for some time to come.

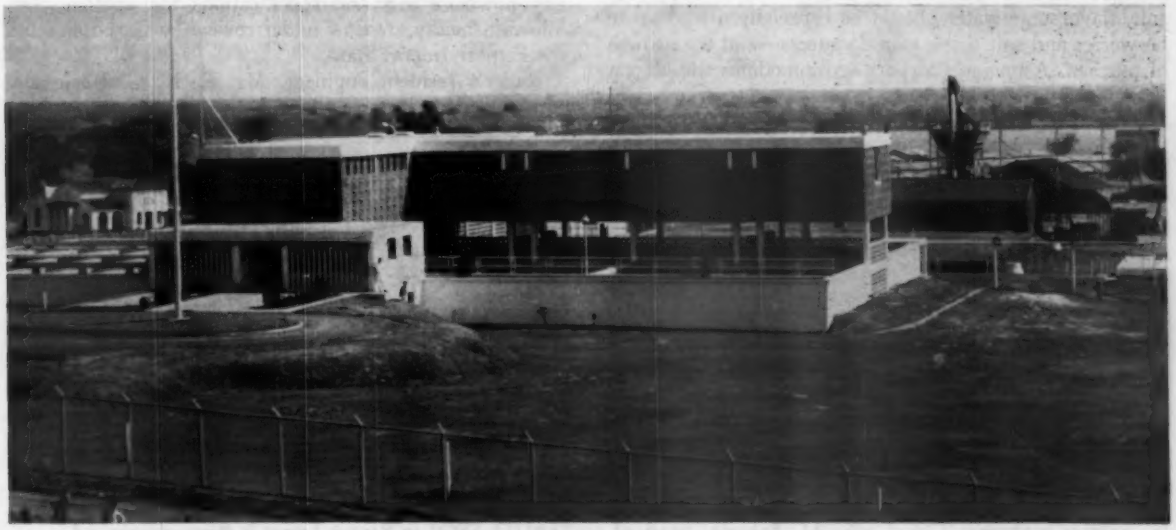
The 250,000 residents of Asuncion are finding the purified water, now being piped by Corposana, the autonomous corporation established by the government to build and operate the new water system, somewhat expensive. For domestic consumption there are two rates: 400 guaranis per month, flat rate consumption, with a flow control valve allowing a continuous flow of one liter per minute maximum, or metered connections with a minimum charge of 600 guaranis per month with a consumption allowance of 1,000 liters per day, plus 15 guaranis per cubic meter for any excess. The current rate of exchange is 122 guaranis to a dollar.

Because the rates are based on the actual cost of providing treated water, the addition of more customers is expected to spread the cost share commensurately.

In the meantime, Corposana is carrying on a lively public education campaign through newspapers, radio and movie theaters in an effort to persuade customers to pay their water bills promptly. Attitudes developed over four centuries are hard to shake, and water bills as such are rude surprises to many Asuncioneros.

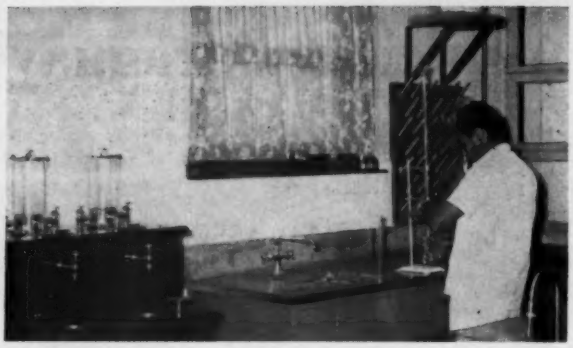
Prior to the advent of Corposana, all water used in Asuncion was untreated. The people who are now connected to the municipal system previously got water either by pumping from a well, in which case the water bill was included in the electric bill, or by collecting rain water in a cistern. In the latter case there naturally were periods of months during the dry season when householders purchased water in limited quantities from vendors. Being confronted every month with a regular bill for water takes getting used to.

Biggest consumer is the national government, which in Paraguay operates all electrical, communications and



WATER TREATMENT PLANT at Vinas Cue, nine miles upstream from Asuncion on the mighty Rio Paraguay, is largest unit in the Paraguayan capital's new $12 million municipal water system.

BEARING BUCKETS and tin cans, young Asuncioneros gather around one of the street fountains which are features of the new water system.



TRAINING LOCAL technicians to take over operation of water system is one of the contract services by Rader and Associates.

TANKS AT THE water treatment plant at Vinas Cue purify the water.

ARCHITECTURAL ELEGANCE of the water treatment plant is seen in this picture of the filter operating gallery.

transportation facilities. Other good customers are oil and textile companies, a large packing house and the national headquarters for the cavalry troops.

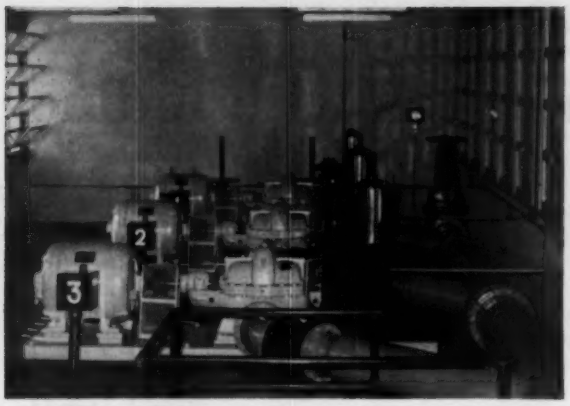
Up-to-date fire protection for Asuncion is the first in the city's history and one of the favorite selling points for Corposana. The commission also looks forward to the arrival of more light industry—an abundant supply of soft, flavorsome water should be especially attractive to breweries and soft drink manufacturers—and the growth of tourism. Asuncion's airport accommodates the largest pure jets from the U.S.

Originally, Corposana expected to rely on Asuncion's municipal power system, but this turned out to be more expensive than was anticipated, with frequent outages making further complications. (Last September 24 there was a five-and-one-half-hour shutdown after lightning knocked out the system.) As a result, the water system for months has been operating on its own 500-kilowatt emergency generator, occasionally supplementing with city power. Plans and specifications for another 500-kilowatt facility are now under review by Corposana and the Export-Import Bank.

Rader's resident engineer, Mr. E. K. G. Borjesson, furnishes daily reports which are fertile with interesting

INSPECTING DIPLOMA of Honor presented by Corposana of Asuncion are left to right: Samuel T. Drew, project engineer for the water system; John W. Greenleaf, Jr., partner-in-charge; Col. Carlos M. Bobeda, head of Corposana; Earle M. Rader, senior partner, who received diploma; Kenneth E. Calendar, another Rader partner.

BEAUTY SPOT in Parque Lopez is this underground reservoir, handsomely crowned with stone masonry and a terrazzo dance floor.



PUMPING STATION at Rodo serves the intermediate level of the three levels of the system.

details . . . "August 29—Mr. Dag Hammarskjold, General Secretary of the United Nations, paid us a visit." . . . May 20—"Went with Col. Bobeda to get five sheep to serve as lawn mowers at Credito Agricola reservoir."

Beautification of the reservoir and pumping station sites is a project which has enlisted the ardor of all the Asuncioneros. Where one underground reservoir was installed in a city park, a polished terrazzo slab was laid on top and is used as an outdoor dance floor.

Col. Carlos M. Bobeda, general manager of Corposana, is at home in the U.S., having been graduated from the Armored School at Fort Knox, Ky., and the Command and General Staff School at Fort Leavenworth, Kans. When he was named head of Corposana in 1955 the corporation didn't even own one chair. Within five years it controlled a $12 million operation. A few months ago Col. Bobeda made a special trip to Miami to present a Diploma of Honor from his nation and the commission to Mr. Earle M. Rader, senior partner in Rader and Associates.

"When we of Paraguay used to visit other countries and cities we would always ask to see their water plants, looking them over hungrily in hope that some day we would have one of our own," Col. Bobeda recalls smiling. "Now they come to Asuncion to see ours."

A New Asbestos-Cement Tile Turns Roofs Into Walk-Ways

A new asbestos-cement tile available from Keasbey & Mattison Co., building materials manufacturer, of Ambler, Pa., transforms built-up roofing surfaces, heretofore unuseable for heavy foot traffic, into serviceable areas.

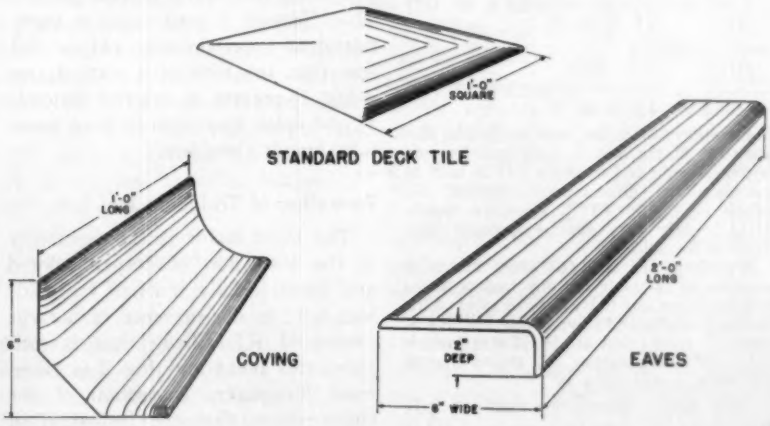
In addition, the tiles keep the felts of the built-up roof from losing their lifegiving oils and otherwise deteriorating under the sun's heat and light. The tiles also protect the roof from the cuts and bruises incurred as a result of careless foot traffic.

The natural light gray asbestos-cement color of the tile is highly reflective, thereby minimizing heat absorption by the black felts.

Called Promenade Tile, the new product is installed on a trowelled-on cold asphalt cement base in an operation similar to installing interior plastic tile. It can be cut with a hack saw or scored for breaking, and can be easily fitted close around irregular shapes and projections.

The standard 12 in. x 12 in. x 5/16 in. Promenade Tile weighs only 3.40 lb. The half-tile section measures 12 in. x 6 in. x 5/16 in. and weighs 1.70 lb. Sizes and weights of accessory pieces are:

Accessory	Size	Wt.
Eaves piece	24 in. x 6 in. x 2 in.	4.13 lb
Coving piece	12 in. x 6 in. x 6 in.	4.50 lb



Installed cost ranges from $.95 to $1.25 per sq ft (retail).

K & M recommends Promenade Tile generally for converting built-up roof areas into usable space on hospitals, hotels and motels, restaurants and residences. It is used on the roofs of some industrial plants to provide recreational areas, and walkways to reach air conditioning units, vents and other roof-mounted equipment.

The product is ideal for residential use over flat areas such as sunporches and sundecks. It has also been used for passenger "step-out" space over black-top in driveways.

Research indicates that serious consideration should be given to . . .

Swimming Pool Disinfection with Iodine

by A. P. BLACK
Research Professor of Chemistry
University of Florida
Gainesville, Fla.

Iodine As An Element

■ I_2 POSSESSES the highest atomic weight of the four halogens, is least soluble in water, is least hydrolyzed by it, has the lowest oxidation potential, and reacts more slowly with organic compounds by either addition or substitution.

These somewhat negative characteristics might at first sight appear to be limiting factors with respect to iodines use for the disinfection of swimming pool water. Actually, however, just the reverse is the case because taken collectively they mean that low I_2 residuals should be more stable and, therefore, persist longer in the presence of organic or other oxidizable matter than any of the other halogens.

In evaluating the effectiveness of any agent for the disinfection of swimming pool water we must be familiar with all of the chemical reactions it is likely to undergo under actual conditions in use. For example, it has been shown that HOCl, formed by the reaction of Cl_2 with H_2O, is most effective and that chloramines, formed by the reaction of Cl_2 or HOCl with ammonia, and hypochlorite ion, formed in increasing amounts as pH increases, are much less effective. In the case of I_2 five different factors and four different substances must be considered.

The Chemistry of Iodine at Pool Residual Concentrations

Hydrolysis of I_2

$$I_2 + H_2O \rightleftarrows HIO + H^+ + I^- \quad (1)$$

$$\frac{[HIO]\,[H^+]\,[I^-]}{[I_2]} = K_h \quad (2)$$

$K_h = 3 \times 10^{-13}$ at 25°C.

Equation (1) shows the reaction of I_2 with H_2O to form hypoiodous acid, and the hydrolysis constant K_h is calculated from equation (2). Its value is 3×10^{-13} at 25°C. Using that value, Chang[1] has calculated the effect of pH on the reaction for total I_2 concentrations of from 0.5-50.0 ppm. Fig. 1 is taken from his paper and shows that, whereas at the higher I_2 concentrations, most of it is present as diatomic I_2, even at pH 8.0; at the residual concentrations encountered in swimming pool disinfection at pH 7.0, about one half is present as diatomic I_2 and one-half as colorless HIO. At pH 8.0 the values are 12 percent as I_2 and 88 percent as HIO. We, therefore, have not one but two active germicidal agents present in the pH range encountered in proper swimming pool operation.

Effect of pH on Forms of I_2

The second factor to be considered is the effect of pH on the conversion of hypoiodous acid, HIO, to hypoiodite ion, IO^-

$$HIO \rightleftarrows H^+ + IO^- \quad (3)$$

$$\frac{[H^+]\,[IO^-]}{[HIO]} = K_a = 4.5 \times 10^{-13} \quad (4)$$

$$[H^+] = K_a \frac{[HIO]}{[IO^-]} \quad (5)$$

$$\frac{[HIO]}{[IO]^-} = \frac{[H^+]}{K_a} \quad (6)$$

Now for pH 8.0

$$\frac{[HIO]}{[IO^-]} = \frac{1 \times 10^{-8}}{4.5 \times 10^{-13}} = 2.2 \times 10^4 \quad (7)$$

And for pH 9.0

$$\frac{[HIO]}{[IO^-]} = \frac{1 \times 10^{-9}}{4.5 \times 10^{-13}} = 2.2 \times 10^3 \quad (8)$$

Equation (3) is the reaction for the dissociation of the acid to hydrogen ion and hypoiodite ion and equation (4) is used to calculate the dissociation constant, K_a, which is 4.5×10^{-13}. In other words, HIO is only very slightly stronger than H_2O as an acid.

Equations (5) and (6) show that it is possible to calculate for any hydrogen ion concentration and pH value the ratio of the undissociated acid to hypoiodite ion. Equation (7) shows that at pH 8.0 this ratio is 2.2×10^4 and equation (8) shows that at pH 9.0 it is still 2.2×10^3.

We find, therefore, that at pH 8.0 there are 22,000 undissociated HIO molecules to each hypoiodite ion and at pH 9.0, which should never be reached in proper pool operation, there are still 2,200 undissociated HIO molecules to each hypoiodite ion.

It is of interest to compare the effect of the pH value on Cl_2 and I_2 residuals. Table 1, taken from the classical paper of Wattie and Butterfield[2], presents the data for Cl_2 and Table 2 for I_2.

The data show that whereas at pH 8.0, 78.5 per cent of a Cl_2 residual is present as relatively ineffective hypochlorite ion and only 21.5 per cent is present as HOCl at the same pH of 8.0, 88 per cent of the corresponding I_2 residual is present as HIO, 12 per cent as diatomic I_2, and only 0.005 per cent, or an unmeasurable trace, is present as hypoiodite ion.

These data have two very important practical implications to the use of I_2 for the disinfection of swimming pool water. First, if it can be demonstrated that HIO is an efficient bactericide in low residual concentrations, then higher pH values than have customarily been employed for swimming pool water become permissible. Second, if pool water is maintained at approximately pH = 8.0, less than one-fifth of a total I_2 residual is present as colored diatomic I_2 and color formation in pool water is no longer a problem.

Formation of Tri-Iodide Ion, I_3^-

The third factor is the possibility of the formation of deeper colored and bactericidally inactive tri-iodide ion, I_3^-, in the presence of a large excess of KI. Chang[1] has investigated this point and Fig 2 is taken from his paper. Inspection of the curve shows that the formation of tri-iodide ion, I_3^-, will not be significant or even measurable at the concentrations of I_2 and KI which would be present in approved swimming pool practice.

Formation of Iodate

The fourth factor is the conversion of HIO to iodate at high pH values. The reaction is as follows.

$$3\,HIO + OH^- \rightleftarrows HIO_3 + 2\,H_2O + 2\,I^- \quad (9)$$

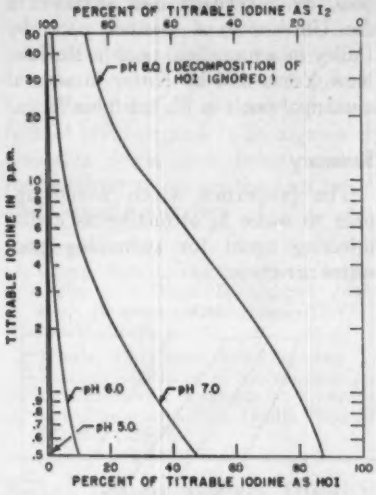

PERCENT OF TITRABLE IODINE AS I_2
100 80 60 40 20 0
pH 8.0 (DECOMPOSITION OF HOI IGNORED)
pH 6.0
pH 7.0
pH 5.0
TITRABLE IODINE IN p.p.m.
0 20 40 60 80 100
PERCENT OF TITRABLE IODINE AS HOI

FIG. 1. THE PERCENT of titrable iodine as I_2 and as HOI in aqueous solutions at 25°C.

In our work with Florida pools, we have not found iodate build-up to be an important factor.

No Reaction With Ammonia

The fifth factor to be considered is the question whether I_2 or HIO will combine with ammonia or ammonia derivatives in pool water to form iodoamines. While it is known that strong solutions of I_2 and ammonia will combine to form the very explosive compound, NI_3, it has been shown that there is no reaction in the concentrations which would be encountered in normal swimming pool operation. This fact constitutes another advantage resulting from the use of I_2 for the disinfection of swimming pool water.

Disinfecting Power of the Various Forms of Iodine

Research workers are not in complete agreement with respect to the disinfecting action of the various forms of I_2 but it is believed that the following statements correctly summarize the best present information.

Studies by Chambers, Kabler, Malaney and Bryant[4]; Chang and Morris[5]; Morris, Chang, Fair and Conant[6]; and Chang[1] have shown that elemental I_2 possesses excellent germicidal properties against all types of pathogenic organisms within a reasonable time at a concentration of a few parts per million.

Some years ago our Armed Services adopted iodine-releasing tablets in place of the Halazone, (chlorine), tablets for disinfection in the field of water in canteens, based on the finding that I_2 in drinkable dosages will kill amoebic cysts while chlorine will not. It also possesses excellent virucidal properties. Wyss and Strandskov[3], in an early paper which is frequently quoted, compared the bactericidal effects of I_2 and HIO. They prepared "pure" solutions of HIO by treating I_2 solutions with a suspension of H_gO, shaking and filtering, which was stated to have removed free I_2, and made available a solution containing only HIO. They found that the bactericidal effect of "iodine free" (the quotes are my own) HIO solutions was only one-third to one-sixth that of an equivalent amount of free I_2.

On the other hand, Carroll, Iannarone and Stonehill[7] prepared solutions of HIO by adding either Cl_2 water or a solution of chloramine-T to a solution of potassium iodide and found that when such solutions are properly buffered there results within seconds a colorless solution of hypoiodous acid. Employing suspensions of *Micrococcus pyogenes* var. *aureus* ATCC 6538—P, and *Escherichia coli* ATCC 9367 as test organisms, they found hypoiodous acid to be roughly four to five times as effective as diatomic iodine vs. *M. pyogenes* and about three times as effective vs. *E. coli*.

Berg, Chang and Kabler, in a paper presented before the 1960 meeting of the American Society of Bacteriologists, stated that:

". . . . . hypoiodous acid (HOI), which increases in concentration as the pH of the water increases, appears to be a more potent virucide than I_2. Preliminary data indicate that on a milligram per liter basis, HOI will destroy 99 per cent of Coxsackie A9 virus at a rate forty times faster than will I_2."

Chang[1] found that the relative cysticidal efficiency of HIO is one-third that of I_2 at 6°C. and one-half that of I_2 at 25°C.

While we have already noted that there will be little or no tri-iodide ion, I_3^-, present in pool water under any presently approved technology, it is well to note in passing that it has little or no germicidal or virucidal action and only slight cysticidal activity, about one-eighth that of I_2. The iodate ion, which will be present in appreciable concentrations only if pool pH values are maintained at too high a level (pH > 8.2), has no bactericidal, cysticidal or virucidal properties.

Results of Swimming Pool Studies Employing Iodine

During the summer of 1958, Black, Lackey and Lackey[8] conducted a study of the effectiveness of I_2 for the disinfection of swimming pool water in Gainesville and Miami, Florida, employing eight pools varying in size from the Olympic-size pool of the University of Florida to small motel pools and in bather loads over 1,700 persons per day to as low as three persons per day. The procedure used was to release I_2 from added potassium iodide with small dosages of either chlorine gas or hypochlorite solution. These workers found that:

"1. When compared upon the basis of halogen residuals in the range usually employed in swimming pools, I_2 was fully effective in the disinfection of the water of the eight swimming pools treated. It was not only equal to chlorine, but in many cases superior.

"2. To maintain the desired I_2 residual, particularly in pools with high bathing loads, required a much smaller applied dosage than was true of chlorine. Such I_2 dosage was only slightly higher than that required for the disinfection of a home-type pool with a low bathing load.

"3. To phrase the above conclu-

Table 1

Percent of Free Available Chlorine

pH	Molecular Chlorine	Hypochlorous Acid	Hypochlorite Ion
4	0.5	99.5	0
5	0	99.5	0.5
6	0	96.5	3.5
7	0	72.5	27.5
8	0	21.5	78.5
9	0	1.0	99.0

sion in another way, I_2 residuals appear to be much less dependent upon bather load than do chlorine residuals. This might be expected because I_2 does not form substitution compounds with ammonia as does chlorine. One may conclude from this statement, therefore, that at the beginning of a bathing peak, a given I_2 residual might be safer than the "free" chlorine residual since there exists the strong possibility that the "free" chlorine residual might quickly be converted to a much less effective chloramine residual, whereas the I_2 residual would not be affected by ammonia introduced by swimmers.

"4. No odors or tastes or irritations of the eyes of bathers were produced by the I_2 residuals employed during the course of these studies.

"5. Although most of the studies were conducted during the hot summer months with high temperatures predominating in seven months with high temperatures predominating in seven of the pools, no visible growths of algae were noted during the testing period.

"6. When I_2 was uniformly distributed throughout the swimming pool either through the recirculation system or otherwise, no brown I_2 color was observed, the over all effect being the production of a pleasing aquamarine green color in the swimming pool water."

In 1959, Black and co-workers[9] reported on the use of I_2 in small home pools lined with vinyl plastic. The bathing loads, mostly children, varied up to a maximum of 30 each day. In this, as in the preceding study, I_2 was found to be effective for the disinfection of swimming pool water.

Marshall, McLaughlin and Carscallen[10] reported on the practicability of I_2 as a disinfectant in a large cooperative community pool in Adelphi, Maryland. In their summary and conclusions they state:

"Iodine was at least as effective as chlorine for the disinfection of swimming pool waters in the volume studied in this report. Iodine did not form complexes with nitrogenous compounds which were irritating to the eye and nucosa of the nose of a substantial number of bathers.

"No difficulties were encountered in the operation of an iodine-disinfected pool with maintenance of free iodine in the range of 0.2-0.6 ppm.

"Due to a decrease in eye irritation, and despite the noticeable color change, a majority of bathers (68.3 per cent) preferred iodine treated water to chlorine treated water."

During the summer and fall of 1960, Black investigated the effectiveness of hypoiodous acid*, HIO, for the disinfection of the water of two hotel swimming pools in Bal Harbour, Miami Beach, Florida—one a fresh water pool, the other containing salt water. In this study HIO residuals were produced by the addition of potassium iodide, KI, and an oxidizing agent. The oxidizing agent used was active over a 24 hour period so that one application daily first released the desired dosage of approximately 20 per cent I_2 and 80 per cent HIO and then re-oxidized the KI formed by the reduction of the two active agents, thus making possible its re-use in a cyclic process. During the two weeks of the test the quality of the water in both pools was such as to meet not only Public Health Service swimming pool standards, but also Public Health Service drinking water standards. It was found possible to effectively disinfect the pools without the production of any color. As was the case in previous studies, no tastes, odors, or eye irritations were present and algal growths did not develop during the period of the test. The treatment was well received by pool users.

During the summer of 1960, HIO was also successfully used by Marshall in the University of Maryland pool, by Stevenson and Wetzler in the University of Denver pool, by Dailey in a municipal pool in Buffalo, New York, and by Kitter in several municipal pools in Philadelphia[11].

*The material used was HIO-DINE, manufactured by Voldale, Inc., Long Island City, New York.

Summary

The properties which would appear to make I_2 attractive as a disinfecting agent for swimming pool water are these.

1. Use in a large number of swimming pools over extended periods of time has demonstrated its effectiveness as a germicide over a wide range of pH values.

2. It does not combine with ammonia to form iodoamines.

3. Its relatively low chemical activity makes it somewhat less dependent upon bathing loads and organic matter present in the water than other halogens.

4. Used in the form of HIO no color is produced in the pool water.

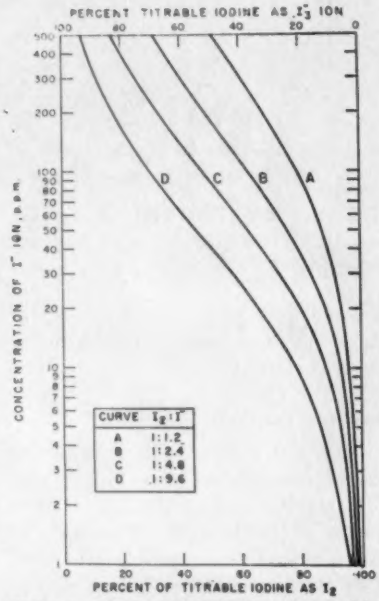


FIG. 2. THE AMOUNTS of titrable iodine I_2 and I_3^- in acidic solutions at 25°C and at varying I_2 : I^- molar ratios.

Table 2

Percent of I_2 Residual of 0.5 ppm Present

pH	I_2	Hypoiodous Acid, HIO	Hypoiodite Ion, IO^-
5	99	1	0
6	90	10	0
7	52	48	0
8	12	88	0.005

5. Odors and tastes are absent and irritation of the eyes of bathers does not appear to result from its use.

6. Lackey, of our research group, has carried out an extensive evaluation of chlorine and I_2 as algaecides and this work, now being readied for publication, shows the two to be about equally effective.

References

1. Chang, Shih L. On the Use of Active Iodine as a Water Disinfectant. *Jour. Am. Pharmaceutical Assn,* XLVIII 6:417 (1958).
2. Wattie, Elsie, and Butterfield, C. T. Relative Resistance of Escherichia Coli and Eberthella Typhosa to Chlorine and Chloramines. Pub. Health Rep., 59 52:1661 (1944).
3. Wyss, O. and Strandskov, F. B. The Germicidal Action of Iodine. *Arch. Biochem.* 6:261 (1945).
4. Chambers, C. W., Kabler, P. W., Malaney, G., and Bryant, A. Iodine as a Bactericide. *Soap and Sanitary Chemicals,* 28:149 (1952).
5. Chang, Shih L., and Morris, J. Carrell. Elemental Iodine as a Disinfectant for Drinking Water *Ind Eng Chem,* 45:1009 (1953).
6. Morris, J. Carrell, Chang, Shih L., Fair, Gordon M., and Conant, G. H., Jr. Disinfection of Drinking Water Under Field Conditions. *Ind Eng Chem,* 45:1013 (1953).
7. Carrell, B., Iannarone, M., and Stonehill, E. H. Some Chemical and Antimicrobial Properties of Iodine Solutions. Presented before the Division of Water, Sewage and Sanitation Chemistry, Am. Chem. Soc., Miami, Fla., April 7-12, 1957.
8. Black, A. P., Lackey, J. B., and Lackey, Elsie Wattie. Effectiveness of Iodine for the Disinfection of Swimming Pool Water. *Am Jour Pub Health,* 49: 1060 (1959).
9. Black, A. P., Boudet, R. A., and Giddens, R. D. Iodine for the Disinfection of Swimming Pool Water. Presented before the Laboratory Section, 87th Annual Meeting, Am. Pub. Health Assn., Atlantic City, N. J., Oct. 20, 1959.
10. Marshall, J. D., Jr. Iodine Disinfection of a Cooperative Pool. *The Sanitarian,* 24, (1960).
11. Kitter, Volda Unpublished data. Private communication.

X-Ray Gauge Assures Quality of Asbestos-Cement Pipe

An electronic gauge is being used for non-contact wall density measurement of asbestos-cement pipe at the Manville, N. J. plant of Johns-Manville, assuring precision control of quality during manufacture.

The corrosion-resistant pipe, know as Transite, is scanned for variations in wall density by X-rays emitted from a closely-controlled source and picked up by a probe tube which enters the pipe during the inspection sequence.

Designated XactRAY, the gauge equipment manufactured by Daystrom, Incorporated, Weston Instruments Division, is suitable for both metallic and non-metallic thickness measurements.

The pipe to be gauged is placed on a motorized carriage, controlled by the gauge operator, which moves the pipe over a pencil beam of X-ray energy. Depending on the density of the pipewall being measured, a quantity of the transmitted electromagnetic energy is received by the probe within the pipe. The probe converts the received signal into an electrical impulse which is in turn transmitted to a floor-mounted console.

The console computes any change in energy received by the probe and converts this data into an indication of wall density deviation. The gauge operator sees density changes indicated by a wide-scale zero-centered meter on the console, and this gives an indication in percent of nominal of density deviation. In addition, a strip chart recording instrument is activated by the gauge to make a permanent record of wall density for each pipe length measured.

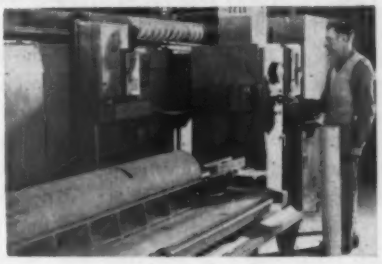
The receiver probe is sufficiently long to permit measurement of the entire length of pipe. Standard lengths range to 13 feet. Whatever the wall thickness, the Weston instrument accurately gauges the pipewall to assure designed density.

"Use of the gauge permits us to detect possible forming variations within minutes," according to Joseph Luszcz, foreman of the wet end section where the Transite pipe is formed. "With the gauge," he said, "difficulties can be traced immediately and time is saved in making the needed corrections."

Normal manufacturing sequence from wet forming to cure and finishing covers a period of about two days, but the non-contact gauge permits measuring the just-formed product after the bried period required to bring the pipe to a semi-hardness. By measuring the wall density almost immediately after the pipe is formed, corrective steps can be put into effect quickly and resulting in continuous adherence to established standards.

In the manufacturing process in wet end section, a blend of willowed asbestos fibers, Portland Cement, and silica combined in a water mix is picked up in a thin coat by an endless sheet of felt. The moving felt conveys the mixture via a series of rolls to a steel mandrel which revolves and builds up a coating of the asbestos-cement. By means of high hydraulic pressure the rolls are forced against the rotating mandrel, compressing the mixture into a tough, dense, homogenous pipe form.

Both pipe and mandrel are removed when the specified thickness is attained and then moved to an electrolytic device which loosens pipe from mandrel. After removal of the mandrel the pipe can be checked for uniform wall density by the X-ray gauge.



Following check-out by the gauge the pipe is placed through several final curing steps, including an air cure period in a room regulated for constant temperature and humidity, before end trimming and machining are done in the finishing department.

Mechanical measuring devices, only capable of measuring pipewall thickness, do not afford the instant measurement variations that enable fast adjustments to be made during the forming cycle. The quick control which this affords creates even greater production efficiency in maintaining the degree of quality and reliability for which Transite is widely known.

Editorial

Palatable From Place to Place

Considerable comment has been generated recently about progress in controlling water borne disease and encouragement in improving water quality. There are indications that some people may not be aware of the search for compounds which may exceed chlorination as an effective disinfecting procedure. That such is not the case is amply demonstrated by Professor A. P. Black's discussion in this issue about iodine as a disinfectant for swimming pool water. Investigations of other halogens and halogen-containing compounds have been and are being made by various researchers. It is to be hoped that reports of progress in these areas will be forthcoming.

The impact, of course, of iodine's use in swimming pools could be felt later in the water supply field. Problems exist in swimming pool water disinfection which need not be discussed here. But there are also problems which exist in potable water disinfection which deserve mention at this time if we are serious about raising the overall quality of water at the consumer's tap.

Among the problems which are no doubt getting some degree of priority is the incidence of infectious hepatitis. Can this incidence be correlated with disinfectant performance? Are we in a position to judge whether substitution of disinfectant is necessary, or warranted? If a substitute disinfectant is indicated, what will it be?

Elusive and evasive taste and odor problems also rear up occasionally at the consumer level. At last month's AWWA meeting in Detroit, someone observed that soft drinks, milk and other products taste about the same from place to place. This tends to knock out comments about transitory differences between individuals and their respective taste buds when water taste and odor complaints are registered. There must be some cause for complaint and there must also be some cause for taste and/or odor development. None of us is truly expert at diagnosing cause of the latter, or at specifying the proper preventative in advance.

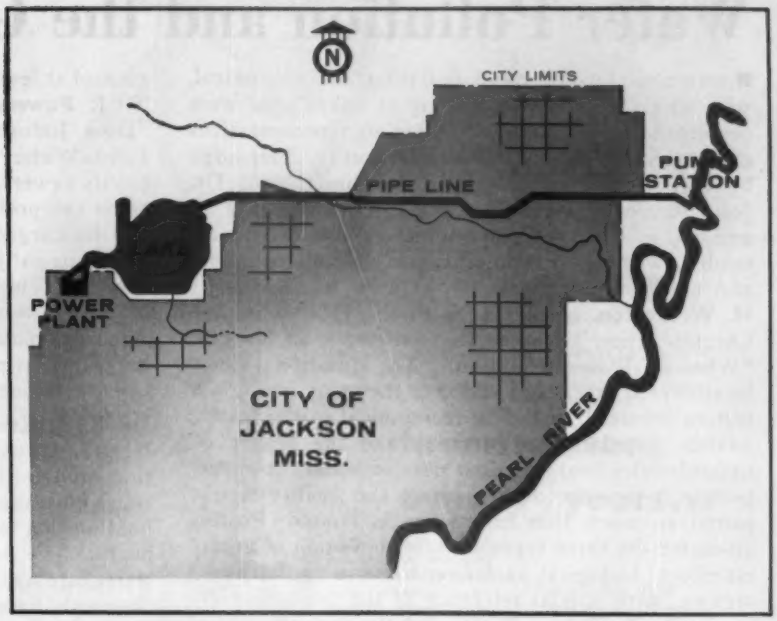
The global nature of our military operations has led to development for the armed forces of an iodine-containing compound for canteen water disinfectant. The material is reported to be standard for both the U. S. Army and the U. S. Navy. It is reported to be effective against the Amoebic cyst, against which the previously used chlorine material was not particularly effective. The development of this iodine material and its use by the military has been adequately reported.

Investigations of iodine's suitability, applicability and effectiveness for general municipal water supply use have not as yet been extensively carried on. There are, though, indications that some of the work reported by Dr. Black might be stepping stones to a fuller understanding of the role of iodine in this application.

For example, if adequate disinfecting power of iodine in potable water can be demonstrated, will the fact that iodo-complexes are not formed in water be helpful in solving troublesome taste and/or odor problems? Or will research uncover new and different problems unencountered with previous disinfecting procedures?

Whatever the outcome of research in this area, and research needs there are, improvements in procedures and a clearer understanding of the problems are sure to result. The day must surely come when travelers will drink water from city to city as free from concern or comment about its taste or odor as they are now about its bacteriological safety. Until then, their favorite cola, at considerably more cost, will probably continue to be not only potable, but palatable from place to place.

V. W. Langworthy



385 Acre Lake Filled By Six Mile Concrete Pipe Line At Jackson, Miss.

Building a reservoir to provide cooling water for a power plant is not unusual. But to supply it with a 6-mile, 20-inch pipe line is.

The Mississippi Power and Light Company's Rex Brown Station at Jackson planned to triple its capacity, but was concerned that pulling more ground water from its wells might materially affect the ground water supply in the area.

They came up with the idea of a reservoir on a nearby unused piece of public land that would do the job. And although some surface water would find its way into the lake, the primary source of water would have to come from somewhere else.

Engineers picked the Pearl River, on the other side of Jackson, as that source. The pumping station was erected, the six-mile prestressed concrete steel cylinder pipe line was laid, and 8,000,000 gallons per day started to flow into the lake. In six months the lake was filled.

The pumps are turned on or off to maintain the water level and according to Consulting Engineers Michael Baker, Jr., Inc. of Jackson, Miss. and Rochester, Pa., the results have been extremely satisfactory.

Taylor-Wheless Company installed the pipeline. Price Brothers Company, with headquarters plants in Hattiesburg, Miss. and Dayton, Ohio, manufactured the pipe.

Far left: A trencher was used on the job. Note backhoe picking up pipe.

Near left: The backhoe was used to place the pipe and to pull home the joint.

Price Brothers
CONCRETE PRESSURE PIPE

Conference at DePaul University considers . . .

Water Pollution and the Great Lakes

■ THE PROBLEMS of water pollution and its control, with special reference to the Great Lakes area, were presented by professional people to representatives of lay groups in this unique conference. Sponsored by DePaul University, under the direction of Dr. John R. Cortelyou, this meeting was held May 15 and 16, in Chicago. Approximately 200 people attended, with good representation of both technical and nontechnical people.

H. W. Poston, of the U. S. Public Health Service Chicago office, keynoted the conference in his talk "What Is Water Pollution?" The question cannot be answered precisely because of the many intangible factors involved, including recreational use of water, wildlife population of streams, and the beauty of natural water-courses. Most uses of water, however, pollute it to some degree; often the quality is impaired so much that future use is limited. Poston discussed the three types of water pollution of greatest effect: biological, including bacteria and viruses; organic, with special reference to the unstable contaminants that cause BOD; and the persistent pollutants, both inorganic (acids, salts, etc.) and organic (detergents, pesticides, solvents, and many chemicals). The speaker reaffirmed that "pollution is a people problem."

C. W. Klassen, of the Illinois Health Department and Sanitary Water Board, spoke on "Water Uses and Their Effects on People." His principal emphasis was, of course, on health. The family requires clean, potable water, disease-free, piped into the home. A clean home and community is one phase of the quality living demanded by the American public. Special problems of water quality that affect the health of infants and children and the health and convenience of elderly people were pointed out.

Mrs. Harold Christensen, of Utah, spoke for the General Federation of Women's Clubs on "Decreased Use of Water for Recreation Can Affect a Significant Segment of the Nation's Economy." The Federation, which today includes six million women, has been active in natural resource protection since 1896. Mrs. Christensen gave several proofs of the importance of water-based recreation to the American people, and of the importance of that recreation to the American economy.

Dr. M. M. Cohn, editorial director for the Reuben H. Donnelley Corporation, discussed "Pollution Control —For the Price of a Candy Bar." We are on the verge of a break-through in water pollution abatement because more people and more interests are speaking out on this topic and expressing their displeasure than ever before. The cost of pollution control should be compared with the cost of pollution itself, including those factors which are difficult if not impossible to evaluate economically. Based on estimates of the Public Health Service and others, the speaker put the cost of pollution and pollution control at less than five cents per day per family.

T. J. Powers, Dow Industrial Service, spoke on "Does Industry Contribute to Pollution of Great Lakes Water?" Most industrial wastes are discharged to city sewers, where they lose their identity and become the problem of the municipality. Wastes that are discharged directly to watercourses cause damage principally in three forms: odor, visible oils, and fish kills. The fault has been more often carelessness or thoughtlessness than poor engineering and design. The man who controls the valve can be just as important in pollution control as the man who controls the money spent.

Dr. E. R. Krumbiegel, Milwaukee Commissioner of Health, discussed "The Significance of Water Pollution on Health." In addition to bacteria and virus-caused diseases, the new chemicals used in the household and on farms may have a detrimental effect on health. The results of these materials, present in water, are apt to be subtle rather than sudden. Few chemicals have been proved to be troublesome, but all must be viewed with some concern as it is almost impossible to prove a total lack of hazard. Our ignorance is especially great with respect to bathing water standards.

Colonel F. W. Chesrow and Emmanuel Hurwitz, Metropolitan Sanitary District of Greater Chicago, spoke on "Water Pollution—A Threat to the Great Lakes Cities." The fresh water in these lakes is a resource of great value, which may some day be shared with more distant communities.

C. C. Davis of Western Reserve University discussed "The Biotic Community in the Great Lakes with Respect to Pollution." All organisms pollute their environment, by their excretions and their death; man does this to a greater degree than other organisms. Professor Davis discussed the gradual deterioration of oligotrophic lakes (lacking nutrients, hence clear and nearly free of plankton) into eutrophic waters containing abundant mineral nutrients and therefore plant life and turbidity. The Great Lakes are making this change, accelerated by the actions of man; and great efforts should be made to retard it.

M. D. Hollis, U.S. Public Health Service, spoke on "Water Pollution—A Changing Image." It is not conceivable that we should go back to the "good old days," hence we must recognize and attack the new problems introduced by advancing technology. We must up-date our thinking and our actions for a solution of today's problems, and tomorrow's. We cannot eliminate pollution; we must moderate it effectively and efficiently by apportioning some of our technological competence to this need. In this endeavor, we must utilize the composite efforts of many scientific disciplines. The public must be alerted—not alarmed—on water pollution; and the presentation should be such as to clarify—not to confuse.

C.F.G.

Proceedings Available

Proceedings of the 15th Purdue Industrial Waste Conference, held in 1960, are now available. Copies may be obtained by sending $3.50 to Dean G. A. Hawkins, Engineering Administration Building, Purdue University, Lafayette, Ind.

NSPE Endorses Extension of National Defense Education Act

The National Society of Professional Engineers has endorsed Administration-backed legislation to extend and expand the National Defense Education Act for three years.

In testimony before an education subcommittee of the Senate Committee on Labor and Public Welfare, Paul H. Robbins, executive director of the 56,000-member engineering group, said that the present law has "provided a valuable incentive for progress in our educational efforts."

Robbins said the National Society "strongly and enthusiastically endorses a permanent extension and substantial enlargement of the existing program of graduate fellowships, for it is in the area of graduate education that direct Federal stipends for individual students will be most productive."

Robbins also testified that the role of the engineering technician in improving the utilization of engineering manpower is such that the Area Vocational Education Programs ought to be revised and broadened in order to strengthen the Federal Government's part in technician training. He urged that consideration be given to the following:

A. A clear distinction should be made between technical education and vocational training.

B. Technical education assistance programs should be classified as a proper function of higher education, and not confined to less-than-college-grade courses as presently conceived.

C. Expanded Federal assistance for technical education might provide funds to assist in the establishment of two-year branch colleges and two-year degree programs at existing institutions.

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News of Suppliers

Marvin Lane, General Mgr. of Graver Water Awarded Title of President

Marvin Lane, general manager of Graver Water Conditioning Co., a division of Union Tank Car Company, has been awarded the new title of president of that division by the Board of Directors of Union Tank Car Company. Mr. Lane has been general manager of Graver Water since November, 1959.

Graver Water is actively engaged in the design and supply of water treatment equipment and processes for power plants, industry, and municipalities, systems for industrial waste treatment and chemical processing applications.

Mr. Lane joined Graver Water in 1949, and, before being named general manager, worked as chief chemist and technical manager, directing a Graver Water research and development program that resulted in major improvements in liquid conditioning processes and techniques, and in the introduction of new items of equipment.

Carus Chemical Co. Announces a New European Subsidiary

Carus Chemical Company, Inc., LaSalle, Illinois, has announced the establishment of Carus Interchemie A. B. at Talstrasse 20, Zug, Switzerland. The Swiss company will license foreign manufacturers to produce potassium permanganate according to production methods developed by the parent organization in LaSalle.

According to M. Blouke Carus, Vice President in charge of Sales and Personnel, who recently returned from a trip to Switzerland to set up this new wholly owned subsidiary, there is an extensive overseas market for potassium permanganate.

Carus Chemical Company is the world's leading producer of potassium permanganate and over the years has developed production techniques that are said to be more efficient than those which exist anywhere else. In addition the company's end-use research laboratories are constantly developing new applications for the purple oxidizing agent. Both the manufacturing and application know-how of the domestic operation will be placed at the disposal of the overseas licensees.

Mr. Carus expects the foreign markets for potassium permanganate to parellel the domestic ones. One of the major uses for potassium permanganate is in the water industry where the chemical provides an economical and efficient method for removal of taste and odors from raw water.

F. A. Speer New V. P. and Works Manager of Mueller Co.

Jackson Kemper, executive vice-president of Mueller Co., Decatur, Ill., has announced the appointment of Mr. Frank A. Speer, as vice-president and works manager. Mr. Speer, formerly plant manager of the New Castle, Pa. plant of Chicago's Crane Co., will direct manufacturing operations for all Mueller Co. domestic facilities.

Mr. Speer, a native of the Pittsburgh area, has had nearly 25 years of foundry and machine shop experience. He was with Westinghouse Electric Manufacturing Co. at East Pittsburgh from 1936 to 1951, when he joined the Bucyrus Erie Corp., Erie, Pa., as production manager. In 1954 he became general superintendent of that firm, and in 1957 was named chief management officer of the New Castle plant.

Mr. Speer's appointment became effective April 17.

Centriline Corporation Opens Chicago Office

Centriline Corporation, a firm that specializes in rehabilitation and lining of pipe lines, has opened an office in Chicago at 111 W. Monroe St. According to N. Young DuHamel Jr., sales vice president, the new office was established to make the company's technical advice and services more readily available in the Midwest.

The company also announces the appointment of Donald A. Stolzman as midwest district manager. Mr. Stolzman, who will be headquarterd in the new Chicago office, previously was with the Koppers Company.

Centriline Corporation, a wholly owned subsidiary of Raymond International Inc., operates on a worldwide basis. The company handles cleaning and lining in place of pipelines ranging from 4 to 144 inches in diameter. Specialized equipment travels through pipelines to apply linings of either cement mortar or epoxy resin.

Four New Sales Offices of U. S. Pipe and Foundry Co.

United States Pipe and Foundry Company, Birmingham, Alabama has announced the establishment of the following four new sales offices:

Earle R. Evans, formerly in Birmingham Sales Office, is now located at Room 229, 3813 Hillsboro Road, Nashville 12, Tennessee. His territory includes eastern Tennessee and Kentucky, except the northern counties.

James W. Crawley, connected with the Kansas City Office for several years, has opened an office at 1013 N. W. 8th Street, Oklahoma City 6, Oklahoma. His territory is Oklahoma and northwestern Arkansas.

Cleo C. Whitlock, formerly water and sewer superintendent for the City of Abilene, Texas, will cover western Texas and make his headquarters at 933 Westwood Drive, Abilene, Texas.

James W. Wilson, well known in the water works business in New Mexico, will handle sales in that state with headquarters at 123 Mesa Verde, Santa Fe, New Mexico.

Foxboro Plans to Acquire Waugh Engineering Co.

The Foxboro Company, Foxboro, Massachusetts, has announced plans to acquire the assets of Waugh Engineering Company of Van Nuys, California, manufacturers of electromechanical and electronic instruments, in exchange for 12,806 shares of its Common Stock. The firm will be operated as a division of The Foxboro Company and will continue under the direction of its founder, Charles C. Waugh. No changes in personnel are anticipated.

In announcing the signing of a purchase agreement, R. A. Bristol, Foxboro executive vice president, emphasized that Waugh products—particularly its turbine flow meters—are an important addition to the extensive Foxboro line of measuring and controlling instruments for the process industries.

Stockholders Approve Name Change for Food Machinery and Chemical Corp.

Food Machinery and Chemical Corporation changed its name to *FMC Corporation* on July 1 of this year. A management proposal to make the name change received stockholder approval at the company's annual meeting held May 23 at FMC's executive offices in San Jose, California.

FMC chairman Paul L. Davies said that the company, as one of the most broadly diversified producers of industrial and agricultural machinery, basic chemicals and defense material, had outgrown its name.

Penn Meter Co. Purchases Penn Instruments Div.

The Penn Meter Company, a newly formed corporation, on April 14, 1961, purchased the entire facility formerly known as the Penn Instruments Division of Burgess-Manning Company. The new company is owned and managed by its officers.

Engineering and manufacturing of Flow Meters and Primary Elements will continue with Mr. W. E. Williams as President and Sales Manager! Mr. William Melas, V.P., resumes his association of many years in the design and engineering of these products. Mr. A. Melas, V.P.-Secretary, and assistant to the president, as well as Mr. W. L. Applegate, Treasurer-production manager, extend their long association with the company.

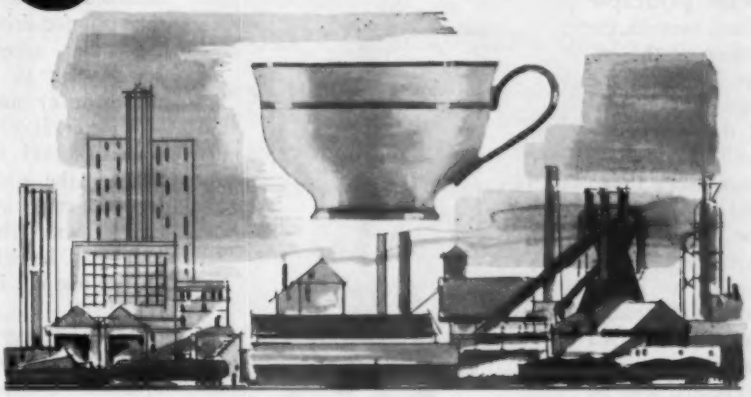
New District Sales Manager for Simplex Valve and Meter Co.

Simplex Valve and Meter Company, a division of Pfaudler Permutit Inc., Lancaster, Pa. announced that Mr. Franklin L. Sommer has rejoined the Company as District Sales Manager for the Philadelphia area.

Mr. Sommer has been actively engaged in municipal sales work since his original affiliation with the Simplex Valve and Meter Company which dated from 1948 to 1955.

His territory includes Eastern Pennsylvania, Southern New Jersey and Delaware, and he will be active in a supervisory capacity with relation to the Pittsburgh, Pennsylvania, Huntington, West Virginia and Washington, D. C. sales offices.

MH Roll-call for water



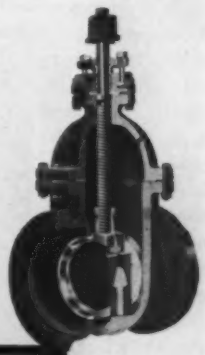
a CUP of WATER

Because until recently it always was available, a cup of water here has been considered a "little thing." Today, we suddenly realize that many water facilities are deficient . . . and a "cup of water" in some places no longer is a little thing!

Of the total population, 26.6 per cent or approximately 25 million citizens of the U.S.A., definitely have inadequate water supply.* In addition water supply is uncertain for 23.2 per cent of the population or nearly 21 million more. Only 50.2 per cent of the population, or approximately 45 million people, enjoy adequate water service. Of 587 water works systems, serving 25,000 population or more each, service is inadaquate or uncertain in 255 of them! The U.S. Department of Commerce estimates that water supply facilities within the next 20 years will need to be doubled.

Municipal and utility officials know this situation but in many cases need better public support before they can make a move. In future advertisements, we will attempt to sketch brief facts about the water shortage of particular groups of states.

*Survey by Water and Sewerage Industry and Utilities Division, Business and Defense Services Administration, U.S. Department of Commerce, Washington, D. C.



M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA

EQUIPMENT IN THE NEWS

For further information on products or services please use reader service card.

Hydrostatic Tester

A complete and simplified device for the internal testing of concrete pipe has been announced by this manufacturer.

The tester employs the bulkhead principle which permits the testing of the entire length of the pipe joint. Internal water pressure itself provides the force necessary to seal the ends of the pipe, and as this force is always a fixed amount greater than the internal force, leakage is prevented and no tensile stresses are set up. Troublesome air inflated inner tube seals are eliminated. The pipe can be tested either in a vertical or horizontal position. The tester is available in two sizes: one for pipe from 6 in. to 10 in. in diameter, and the other for pipe from 12 in. to 24 in.—Cascade Metals Corp.

For More Information Circle No. 701 on Reader Service Card

Transistorized Pipe Finders

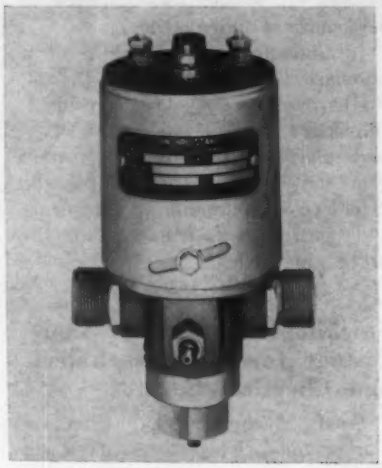
Reduction of maintenance costs by 90 per cent were reported in extensive field tests of the new Fisher Model M-Scope Pipe Finders. Equipped with hermetically sealed transistors and printed circuits they proved to be superior to conventional models using vacuum tubes and circuits. In addition, battery life of the new transistorized units averages more than 1500 hours of continuous operation.

Other features include indestructible fiberglass cases, single turn anodized aluminum loop antennas, built-in battery testers and a detachable carrying belt for drop-handle operation.—Fisher Research Laboratory, Inc.

For More Information Circle No. 702 on Reader Service Card

G T Style Drive and Mounting

This manufacturer announces new GT style units that will mount directly on a standard .187 shaft S.A.E. tachometer take-off. In addition, they provide two side take-offs, one of which rotates clockwise and the other, counter clock-wise. Flexible cables can be attached to these take-offs for driving other accessories such as a tachometer and hourmeter. If only one take-off is needed, the protective cap included with the unit may be left on the one not in use.

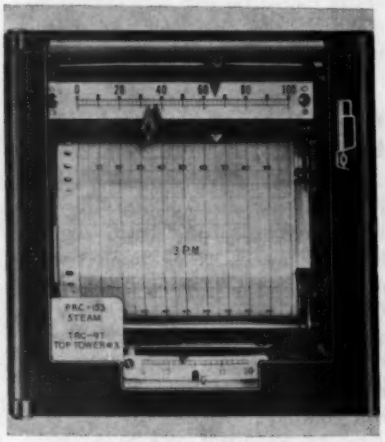


The auxiliary take-off shaft is driven by precision right angle helical gears at the same speed as the governor shaft.—Synchro-Start Products, Inc.

For More Information Circle No. 703 on Reader Service Card

Metagraphic Pneumatic Receivers

A new line of 4-inch chart Metagraphic pneumatic receivers has been announced by this manufacturer. Built to a completely new design, these instruments, designated as the Series 670, are best described as being user oriented. Many new features, both standard and optional, combine to make the Series 670 easy to install, easy to use and easy to maintain. Nine models are presently available to meet any control requirement.



The four-inch calibrated width chart has rectilinear coordinates for easy reading and interpretation. Capillary inking systems, (up to 3 records) provide trouble free recording, and are refillable from the front of the case.—The Bristol Co.

For More Information Circle No. 704 on Reader Service Card

Submersible Dewatering Pump

An 8-inch Submersible Dewatering Pump, identified as Model S8A1, is now available from this manufacturer.

The capacity ranges from 1000 gpm at 148 ft head to 2700 gpm at 40 ft head. It has an oil filled motor housing for increased cooling and dual seals that run in oil. Height is 31 in., diameter 28 in. Aluminum construction reduces weight to 775 pounds. Strainer area is 480 square inches with 1 inch square openings. —The Gorman—Rupp Co.

Circle No. 706 on Reader Service Card

Automatically Controlled Bar Screen Cleaning

Bar screens, Traveling Water Screens, etc., may be cleaned automatically with the new Devco series HM differential head control system. Devco Bar Screen intermittent race control eliminates the danger of excessive debris build-up and unsatisfactory service due to daily or seasonal variations in amount of water, wastes or sewage treated with resultant lower power costs and prolonged equipment life. The Devco series HM units may be either indicating or recording, and can be furnished with repeat signal assemblies for remote supervision.—Devco Engineering Inc.

Circle No. 707 on Reader Service Card

Ball Valves

Marketed under the trade-mark of "Double-Seal", this manufacturer's ball valves offer many advantages. The design features full pipeline flow and is recommended for practically all systems that require either continuous or infrequent cycling.

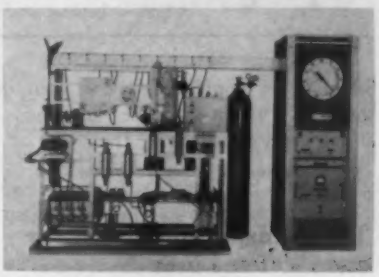
These valves may be manually, electrically, pneumatically or hydraulically operated. They offer trouble-free operation, no leakage, no lubrication, no contamination and minimum maintenance. Operating temperature range: —150° F +450° F. Size: ½ to 10 in.—Jamesbury Corp.

Circle No. 708 on Reader Service Card

Waste Water Analyzer

An analyzer that continuously determines and records dissolved organic matter in chemical plant waste water or any aqueous stream, is available from this manufacturer.

The unit offers full scale sensitivity of 200 ppm by weight of organic carbon which may be extended



to about 1000 ppm. Concentration

CONTINUED ON PAGE 94A

Protection, clear to the city.

Dry HTH hypochlorite helps keep water sanitary, *right* from the reservoir to the drinking glass. Around watersheds, in pipelines, in new wells . . . HTH releases effective, dependable chlorine to kill bacteria, algae and fungi fast. Comes in pails, drums and new plastic bottles. Write for literature. Olin Mathieson, Baltimore 3, Maryland.

Here's to Health . . . **HTH®**

CHEMICALS DIVISION Olin

Equipment News

CONTINUED FROM PAGE 93A

changes of approximately 1 ppm of organic carbon can be detected.—Lockwood & McLorie, Inc.

Circle No. 709 on Reader Service Card

T. V. Inspection of Sewer and Water Lines

A complete television system for the inspection of sewers, water lines, conduit, wells, water tanks, etc., is now available from this manufacturer.

This water tight system is complete with an enclosed lighting system, 500 or 1100 ft. of cable, and generator. The system is capable of being pulled through pipelines as small as 4 in. in diameter and as large as 48 in. in diameter.—Inspectoline Inc.

Circle No. 710 on Reader Service Card

• Pump Motors

This manufacturer offers a complete line of polyphase vertical hollow shaft electric motors for any pump requirement.

Some of the important features are: angular-contact ball thrust bearings designed for long life and minimum maintenance; interchangeable P and PH base construction that permits increasing motor hp without the expense of changing the pump head; rotor and shaft dynamically balanced as a unit to reduce vibration; all weather operation; dual balanced ventilation; self-release coupling that eliminates possibility of reverse pump rotation; metered oil flow that assures proper lubrication; heavy cast-iron construction; sealed-bearing chamber that keeps oil and oil vapor in, and dust, dirt and moisture out; Thermoseal® insulation system.—A. O. Smith Corp.

Circle No. 711 on Reader Service Card

Trash Rake

A new trash rake with a dual hoisting mechanism that controls tooth action for digging or dislodging debris at any point on the trash racks has been announced by the manufacturer.

The new unit is designed so that when the rake is lowered, its teeth point downward and parallel to racks. When the bottom position is reached, the teeth turn inward toward the trash rack with a digging action, thereby providing an effective raking position for a cleaning pass. Upon reaching the top position above the trash apron and car, the rake teeth are tilted and the debris is dumped.

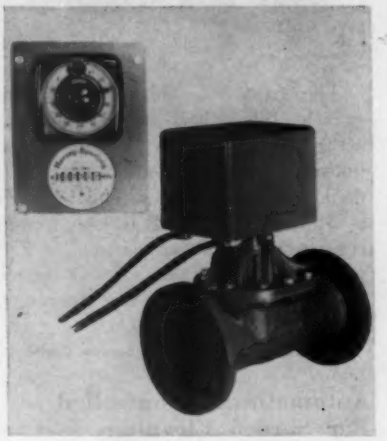
Where heavy, dense or floating debris, such as tumbleweed, water hyacinth, etc., is encountered in the

water intake, the rake can be lowered so that the teeth penetrate the debris and tear it apart. The main hoist then pulls the rake and its load of trash back up.—Allis-Chalmers Mfg. Co.

Circle No. 712 on Reader Service Card

Coin-Operated Dispensing Meter

A coin-operated dispensing meter for use where there is intermittent or sporadic water consumption, has been announced by this manufacturer. The unit features a 6-digit straight-reading totalizer for permanent record of all flows.



Delivery quantities may be regulated in volumetric units from 100 to 10,000. Remotely located coin box is furnished to accommodate 5, 10, or 25 cent pieces, or with special box for tokens. A solenoid-controlled valve permits a preset volume of water to be dispensed whenever a coin, or token is inserted.—Hersey-Sparling Meter Co.

Circle No. 713 on Reader Service Card

P V C Ball Valves

This manufacturer's patented "Double-Seal" Poly Vinyl Chloride Ball Valves have been designed for use with normal or high impact P V C or other plastic piping. They are constructed entirely of unplasticized normal impact corrosion-resistant polyvinyl chloride, with the exception of seats, seals and bonnet plate. Their unique design eliminates plastic-to-plastic moving parts, thus preventing galling or seizure. These valves may also be used on many metal pipe systems. Sizes: ¼ to 2 in., 3 in., and 4 in.—Jamesbury Corp.

Circle No. 714 on Reader Service Card

Speed Sensitive Switches

Included in the extensive line of speed sensitive switches offered by this manufacturer are Multiple Element Switches equipped with 4, 5, or 6 sets of contacts, all of which can operate at different speeds. They are adaptable to any type of rotating machinery where it is necessary to open or close a multiplicity of contacts at different speeds.

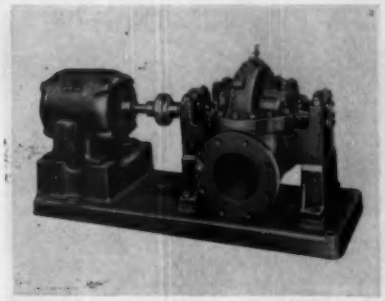
Switch contacts in all models are snap acting so as to eliminate contact chatter and their trip points are adjustable after installation. Standard units can be supplied to operate contacts at speeds between 300 and 7000 rpm.—Synchro-Start Products, Inc.

Circle No. 715 on Reader Service Card

Centrifugal Pumps

This manufacturer announced the addition of new sizes to its Model 3405 line of single stage, double suction centrifugal pumps.

Thirty-four sizes are now available to provide capacities from 100 to 6400 gpm with heads up to 525 ft.



A choice of grease or oil lubricated bearings, wide degree of interchangeability of parts, availability in stainless steel and ductile iron, are among the many features of this group of pumps.—Goulds Pumps, Inc.

Circle No. 716 on Reader Service Card

Automatic Power Rodder

The new O'Brien Power Rodder features positive rod drive and 20,000 lbs pull-back power. Pilot models have proven ideal for bucket threading, sewer rodding or for cleaning and threading underground conduit. Rodder is used with 5/16 in. and 3/8 in. rod. Unit is fully enclosed, equipped with automatic safety throwout controls and is compact for easy mobility and transport. Footage meter indicates position of cutter and obstruction. Controls are conveniently grouped for one man operation. The new Rodder is available in both trail-type and truck mounted models. Heavy duty 9 or 12 hp engine with 12 volt starter, generator and battery. 1200 ft. capacity. —O'Brien Mfg. Co.

Circle No. 717 on Reader Service Card

De-Ionization Equipment

Standardized Packaged De-Ionizers designed for easy and convenient installation are offered by this manufacturer.

These units are shipped completely assembled, mounted on a welded steel base, ready for connection to

CONTINUED ON PAGE 97A

TRIANGLE BRAND COPPER SULFATE

Small, economical dosages of Triangle Brand Copper Sulfate will make your water supply palatable. It destroys algae and aquatic weeds that cause bad water odors and give water an unsavory taste. ■ Another important use of Triangle Brand Copper Sulfate is for the control of root growths, fungi and slime in sanitary sewers and storm drains without damaging trees and shrubs. ■ Write today for complete information on the use of Triangle Brand Copper Sulfate in water supply systems, sewers and drains.

NICHOLS TRIANGLE BRAND CHEMICALS

phelps dodge refining corporation

300 PARK AVENUE • NEW YORK 22, NEW YORK

KEEP 'EM ROLLING

by C. G. Cunningham

■ IF YOU HAVE any dual tires on your water and sewer department rigs, there's a new tire that you'll find most interesting. It is different, a new idea that most new tires can't match.

This tire is Firestone's *Duplex*, now in limited production, and it is made to take the place of two normal dual tires on dual rims.

From all reports the tire is practical, tends to save both time, tire wear and pounds for the user. Lighter weight of the combination appeals to many truckers, and while not a major concern in our business, there are other good features that do concern us.

For one, less maintenance is reported. You have just half as many units to check, to pressure, to maintain. This means reduced inventories, —fewer tires to backstop.

Extra rims and wheel spacers are eliminated. A total of 24 parts, eight tires, rims and wheel spacers, are not needed with the duplex tire on a tandem tractor-tandem trailer unit.

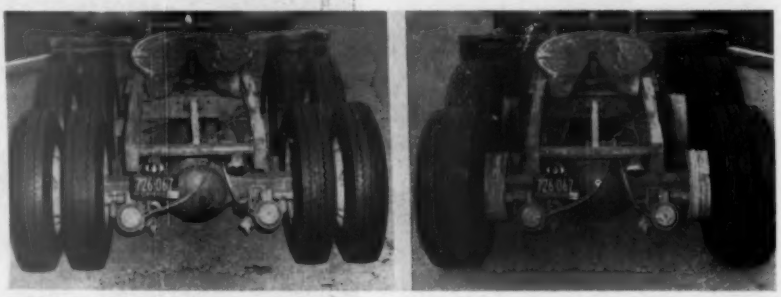
The next time you check your distributor points for wear or pitting, look for signs of oil blackening on the points and on the inside of the distributor housing. Excessive oil, or oil deposits, at any of these spots, is either a symptom of over-lubricating or of leakage up past the distributor shaft. Examine the shaft bushings and seals for looseness, wear or deterioration. The distributor is so important to overall engine functioning that any worn parts should be replaced immediately.

Is your oil filter still working? Check it by putting your hand on it. If it is hot, hot oil is circulating through it. If it is cold, it's plugged and the oil is bypassing it. Time for a change.

That new oil change may not do much good—if you didn't also change your oil filter. Wonder detergent oils can't do the whole job of lubrication—they need a filter to trap a lot of the dirt.

A filter catches the medium-sized particles that build up inside your engine. These get trapped quickly in the filter, because oil circulates completely in most engines once every thirty seconds. That means a total oil flow of 800 gallons an hour!

Heavy particles in the oil drop to the bottom of the crankcase and are removed during oil changes. But the fine particles go right through filters. They keep circulating and eventually stick together with other particles, producing sludge. Sludge sticks to odd corners of the engine, and doesn't circulate, causing trouble.



DUPLEX TIRES take the place of normal dual tires on trucks. New tire cuts down on weight, parts, maintenance, and back stock of spare tires.

Detergent-dispersive oils are specifically designed to keep these particles from sticking together, and to separate those that already have. The particles stay trapped in the oil stream until the next oil change.

A dirty filter cant' do its share of this cleaning work,—and that overworks the oil, making it unfit for use quicker. If you neglect the filter, you shortchange your oil's potential.

A filter also picks up acid and water to help prevent corrosion in an engine. It quickly becomes saturated with these elements.

When the filter becomes loaded with water and dirt, a pressure valve opens and the oil by-passes the filter entirely. So a dirty filter means *no oil filtering at all!*

Many truckers change filters every time they change oil. Others change only filters, never the oil. Others change filters every other oil change. Work out your own oil filter change interval and stick to your filter servicing schedule. You'll be dollars ahead when you do.

Get more wear and better mileage out of your truck tires. B. F. Goodrich offers these suggestions—know more about your tires and how to take care of them. They offer these tips:

Overinflation and underinflation are two tire wear causes. Overinflation can seriously damage your tires. It does not compensate for overloading. It does not add strength to the tire. In fact, it actually weakens the cord body by reducing its ability to absorb road shocks.

Overinflation leads to: rapid wear in the center portion of the tread; increased tendency toward bruises and impact breaks; excessive strain on beads and rim; abnormal tire growth, stretching of tread and tread cracking; abnormal stresses and strains in the tread that lead to separation; more cuts and snags; harder riding and reduced cushioning leading to increased upkeep cost on equipment; reduced traction and

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Equipment News

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raw water, drain and effluent piping. Each assembly includes the exchange column (or columns), proper ion-exchange resins in place, all internal and external piping with necessary valves, effluent purity meter, flow meter, vessels for the regenerants, and an operating panel. Various sizes are available with flow rates up to 2,000 gph.—Illinois Water Treatment Co.

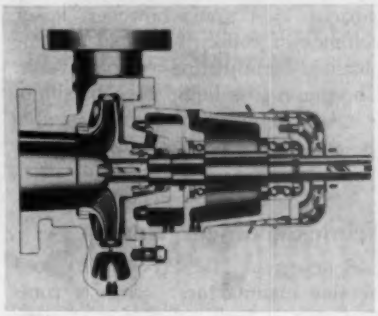
Circle No. 718 on Reader Service Card

Process Pumps Feature Interchangeability

An entirely new line of standard process pumps that offers the application flexibility of custom-engineered models has been announced by this manufacturer.

From two basic pump types, the SMJ and SMJI, up to 72 basic combinations are possible. By interchanging impellers, covers, nozzle arrangements, bearing construction, cooling methods, and other components, the requirements for almost any given service can be met from standard, off-the-shelf parts.

Model SMJ is designed for high temperature service with either top or end suction. For lower temperature service, the SMJI is recommended. Capacities are available to 1200 gpm, differential heads to 1600 ft, pressures to 1000 psi.—Byron Jackson Pumps, Inc., subsidiary of Borg-Warner Corp.



Circle No. 719 on Reader Service Card

Pelletized Herbicide

Marketed under the trade name of Chem Pels 2, 4-D, a new pelletized herbicide is now available.

This product has been developed in an insoluble ester form for slow, regulated toxicant release of ingredients to the plant intake structure. The granules are not affected by water dilution, depth or flow and provide effective residual lethal concentrations for periods of one to three years. They are non-toxic to humans, animals, fish or aquatic organisms and produce a slow killing action to broadleaf weeds. Pellets are applied at the rate of 100 to 150 lbs. per acre.—Chemical Insecticide Corp.

Circle No. 720 on Reader Service Card

Submersible Pumps

A new line of 8 in. submersible pumps has been announced by this manufacturer.

The new Series F pumps are available in sizes from 10 hp through 50 hp with a capacity range from 150 gpm to 550 gpm in three basic impeller sizes. They are well suited to meet industrial, commercial and municipal water supply requirements. The pumps can be used in wells or as horizontal or vertical in-line boosters.—Sumo Pumps, Inc.

Circle No. 721 on Reader Service Card

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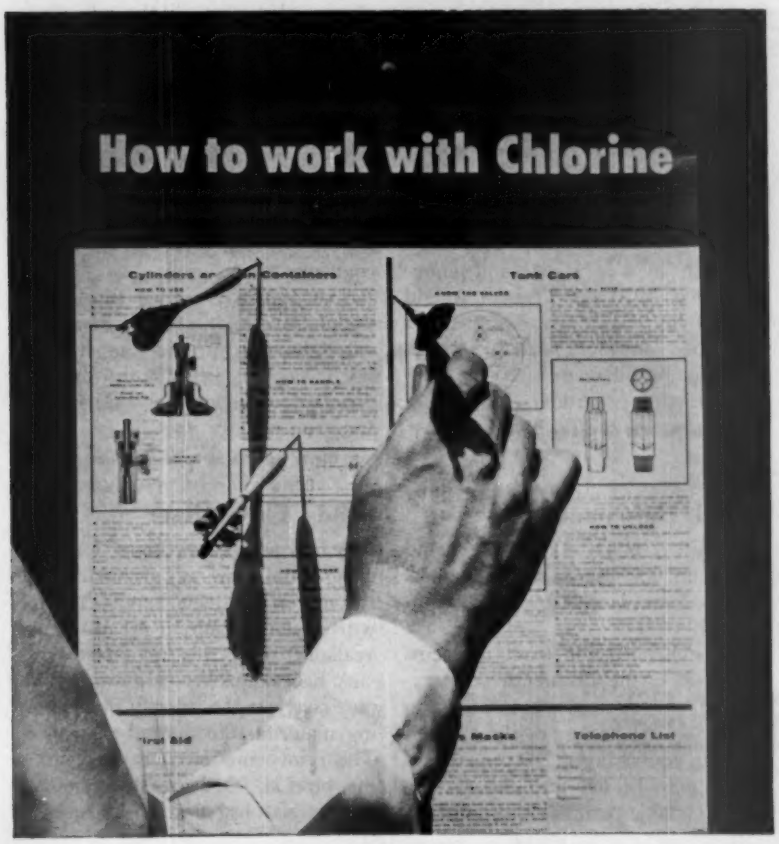

YOU CAN'T PLAY GAMES WITH SAFETY

Before your crew takes that safety chart too lightly, remind them of the consequences of carelessness.

Chemical manufacturers exercise ev ery possible precaution in the packaging, shipping and unloading of hazardous chemicals. And we do everything we can to recommend safe practices among the users of such products. So . . .

DON'T TAKE CHANCES. If you'd like more copies of our safety charts on products such as chlorine, let us know. There's a 76-page manual available, too. Ask for it.

HOOKER CHEMICAL CORPORATION
1707 UNION STREET
NIAGARA FALLS, N.Y.

HOOKER CHEMICALS PLASTICS

Sales Offices: Buffalo, Chicago, Detroit, Los Angeles, New York, Niagara Falls, Philadelphia, Tacoma, Worcester, Mass.

In Canada: Hooker Chemicals Limited, North Vancouver, B. C.

Equipment News

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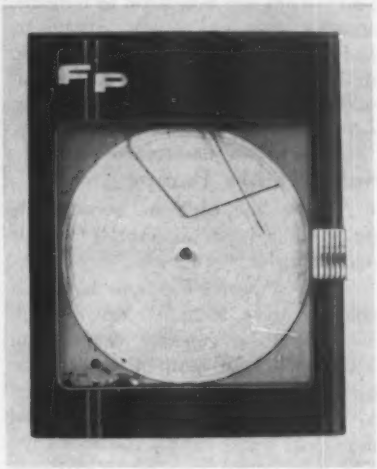
Fully Transistorized Recorder

A rugged and compact recorder having fully transistorized circuitry, positive drive action, a built-in volt-



meter, and a direct reading range dial has been introduced by this manufacturer.

It provides an exceptionally stable, noise-free magnetic flowmeter a-c potentiometer. The entire unit is built on a single removable chassis. Amplifiers and pre-amplifiers and a range network are mounted on plug-in cards that can be easily removed and replaced in seconds.

The Transistorized Recorder features an automatic quadrature rejection which requires fewer adjustments; easy access to controls; positive "on" indication; electronic smoothing; and a built-in dashpot. The single depth case may be direct wall-mounted.—Fischer & Porter Co.

Circle No. 722 on Reader Service Card

Effluent Sampler

Pumping type effluent sampler, only 7½ x 8½ x 18 in. overall size,

is portable. Motor and clock controls are housed in a sturdy metal case with carrying handle.

Unit operates for 15 seconds at regular intervals of 15 minutes. Pump capacity is 4 gpm; however, lesser volumes of collected sample may be obtained by adjusting a bypass valve. The pump lifts liquid to a height of 6 ft.—Phipps and Bird, Inc.

Circle No. 723 on Reader Service Card

Triplex Plunger Pump

A new pump, the PT-4, introduced by this manufacturer offers a compact unit of high volumetric efficiency. It is a triplex plunger pump which operates 70 hp input at 400 rpm.

Low pressure range of the pump is from 510 psi to 1563 psi, while high pressure range maximum is 3000 psi. Plunger sizes are 3½ down

to 1¼ in. by 4 in. stroke and plunger load is 4910 lbs. Overall weight is 1370 lbs. Especially designed for waterflood and salt water disposal, these pumps fill many needs in general industry.—Gardner-Denver Co.

Circle No. 724 on Reader Service Card

Liquid Defoamant

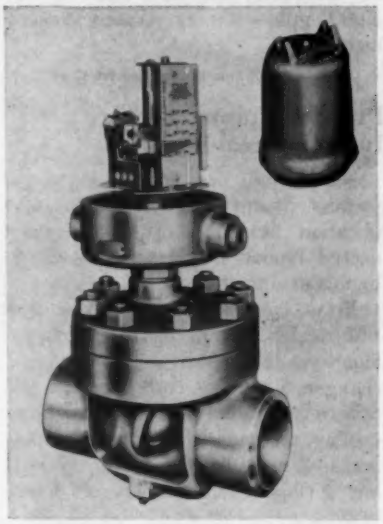
Identified as DF-12, a new liquid defoamant for use in aerator tanks has been announced by this manufacturer.

Recommended for foam problems regardless of the altitude or temperature of the region where it is to be used, DF-12 is easily applied through conventional garden sprayers or may be fed into the aerator with a suitable pump at approximately 0.5 to 1 part per million. Packaged in convenient 55-gallon containers it is completely safe to use anywhere in the sewage plant.—National Chemsearch Corp.

Circle No. 725 on Reader Service Card

Full-Flow, Swing-Check Valve Combination

A full-flow, swing-check valve that offers all the advantages of a



check valve plus all the advantages of a flow control, for practically any liquid at any pressure or temperature, in one compact package, is now available from this manufacturer.

The new Model F C V Magnetrol offers a valve disc magnetically coupled to the switch mechanism, which features mercury-to-mercury switch contacts.

The unit is designed to remotely signal flow or no-flow through the valve; and/or provide an interlock safety control in start-up or shut-down, flow or no-flow.—Magnetrol, Inc.

Circle No. 726 on Reader Service Card

Solids Flow Meter

A new solids flow meter for measuring total flow of granular material in vertical ducts, spouts, or pipes with diameters up to 40 in. is now available from this manufacturer.

A helical quarter-turn vane in the pipe converts the velocity of the flowing material into a rotational speed. The rotary motion is carried out of the pipe at 90 degrees to the flow of material by means of a flexible

shaft and a set of change gears. The shaft operates either a direct mechanical counter or an electric contact mechanism to operate a remote counter.—Bailey Meter Co.

Circle No. 727 on Reader Service Card

Square Bottom Gate Valves

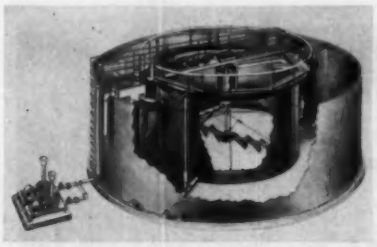
This manufacturer offers Square Bottom Gate Valves designed for use in filtration and sewage disposal plants. They are used for throttling, in a partly open position, or installed in a horizontal position in vertical pipes, to give longer service life with less wear on the seat and disc faces. Sizes 4 through 48 in.—Darling Valve & Manufacturing Co.

Circle No. 728 on Reader Service Card

Sewage Treatment Plant

A new sewage treatment plant, designed to be field-erected at the job site, has been announced by this manufacturer.

The new unit, Model R "Oxigest", will be fabricated in 17 sizes from 30,000 to 500,000 gallons per day, to serve small communities, subdivisions and other facilities from 300 to 5,000 persons.



The manufacturer will supply, assemble and erect the Model R units on the purchaser's foundation with all material and equipment necessary for a complete, ready-to-operate sewage treatment facility. Under normal conditions, the purchaser will be responsible for the excavation, foundation slab, backfilling, inlet and outlet sewer connections and power supply to the electrical control panel. —Smith & Loveless Div.,—Union Tank Car Co.

Circle No. 729 on Reader Service Card

Check Valves

This manufacturer offers a completely new line of horizontal swing check valves.

Designed to operate dependably in either vertical or horizontal positions, the new valves incorporate construction features which provide unusual flexibility of operation. They may be converted in the field from plain to single or double-level operation to meet changing requirements. Available in sizes from 4 through 12 in. —Eddy Valve Co., Subsidiary of James B. Clow & Sons, Inc.

Circle No. 730 on Reader Service Card

Measurement and Control of Flow of Dry Materials

The need of continuous process industries for measurement and control of flow of dry materials at low to medium rates is met by this manufacturer's Model 36-02 Belt (Stream) Weigher.

Operating in a 10:1 range with Constant Speed Drive or 40:1 with Variable Speed Drive, the Model 36-02 will measure dry material with accuracy and will continuously integrate weight of material with belt speed. The weigher will measure maximum rates from 10 lbs per minute to 60 tons per hour, depending on material characteristics.—B-I-F Industries.

Circle No. 731 on Reader Service Card

a few plain words about...

WATER METERS!

METER YOKES

The Ford Yoke dates back to 1911. Its outstanding success resulted in a wide variety of meter holding devices called yokes. But the Ford yoke as now made offers advantages not obtainable in any other type of meter setting. Millions are in use.

LIFTER WORM LOCK

The original Ford Worm Lock was introduced almost forty years ago. Because of its simplicity, safety and powerful screw-jack action it is now widely used. The Lifter feature, a recent improvement, provides automatic attachment of the key on unlocking.

CALIBRATED TESTING TANKS

Before Ford Calibrated Testing Tanks were put on the market about 35 years ago, such meters as were tested were checked against gravimetric scales, which were complicated and inconvenient. Thousands of Ford Tanks are in service, in sizes from one to 1000 gallons.

METER VALVE

The Meter Valve is a close-coupled combination of an inverted key valve and a meter connection. It saves material, pipe joints and space in the meter setting. Ford Meter Valves bear the trademark name of Ringtyte Valves.

THE KORNERHORN

In a vertical basement pipe, against the wall or in a corner, the Kornerhorn makes a most satisfactory meter setting. Installation is fast and economical as pipe threading is eliminated. Send for detailed information.

Meters can *earn* real money. In most water utilities they measure and determine *all* the income.

It is good business to accord meters the treatment they deserve as valuable equipment and as sources of revenue. Such enlightened treatment includes settings which provide protection, easy availability for reading, and trouble-free meter changes for proper maintenance.

For 60 years our company has served thousands of water utilities in providing better water meter settings. Submit *your* problems to Ford.

THE FORD METER BOX COMPANY, INC.
FOR BETTER WATER SERVICES
WABASH, INDIANA
FORD

New Literature

AVAILABLE FREE

Pool Water Treatment

"One Chemical for Complete Pool Care," a 4-page brochure, describes this manufacturer's All Purpose Chemical, identified as A.P.C., that takes care of all the essential needs of pool water treatment.

This product contains chlorine, algaecides and clarifiers. It prevents and kills bacteria and algae, keeps water crystal clear and makes maintenance easier for swimming pool owners.

The brochure explains method of application and dosage.—Modern Swimming Pool Co.

Circle No. 732 on Reader Service Card

Venturi Tube Accessories

An up to date bulletin on Venturi accessories has been published by B-I-F Industries, manufacturers of equipment and systems for positive control of materials flow.

The four-page bulletin gives both description and diagrams on Straightening Vanes, Vent Cleaners, Flushing Devices and Special Chambers. Arrangement drawings clearly detail proper installation and application.—B-I-F Industries.

Circle No. 733 on Reader Service Card

Plastic Pipe

4-page brochure describes new acrylonitrile-butadiene-styrene plastic pipe.

In addition to illustration of the various applications of this semi-rigid pipe, bulletin contains tabular data on physical properties, rated working pressures, sizes and weights. It also presents a step-by-step description of the recommended method for joining the pipe, including several field procedures useful in assuring leak-proof installations.

Applications include water service, submersible pump service, irrigation and sprinkler systems, jet well settings, natural gas lines and oil field piping.—Johns-Manville Corp.

Circle No. 734 on Reader Service Card

Velocity Type Totalizing Liquid Flow Meter

4-page Bulletin 380.20-2 illustrates and describes Model 380 Propeloflo Meter recently introduced by this manufacturer.

Especially designed for metering water and other liquids in water works and chemicals or process industries, the Model 380 is easily installed. Highly accurate, it requires no pipes or mercury and totalizes directly. The high tensile cast iron body construction with molded plastic propellor of high impact strength makes possible a sturdy, durable meter that will withstand and register overloads up to 15 percent.

Available in eight different line sizes, it can measure flow from a minimum of 20 gpm up to 2400 gpm. —B-I-F Industries.

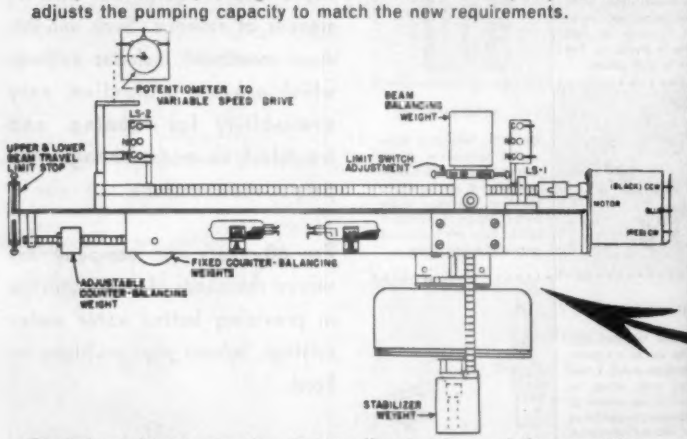
Circle No. 735 on Reader Service Card

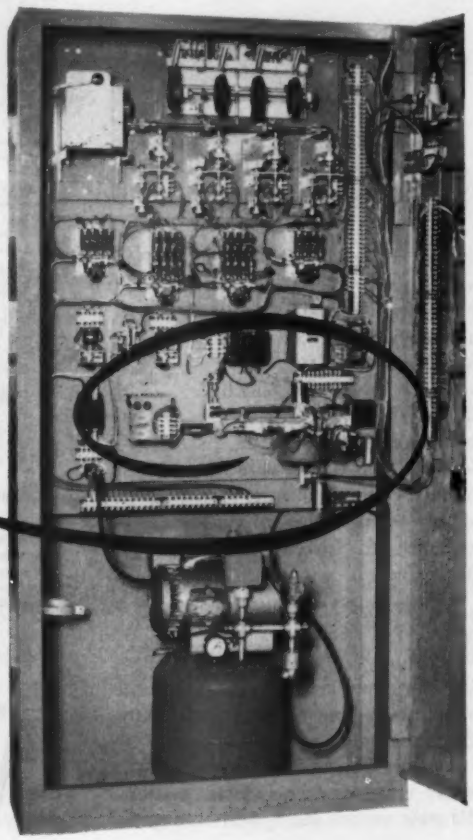
Special Tools and Equipment Save Effort and Time

A brochure recently issued illustrates and describes this manufacturer's extensive line of tools and

New Balance-Beam Control for Variable Speed Pumps

Healy-Ruff's new Serv-trol uses the balance-beam principle to match pumping speed to system requirements. Any change in system pressure or liquid level upsets the balance, and repositions a pilot potentiometer. The potentiometer, through a servo mechanism and pump controller adjusts the pumping capacity to match the new requirements.





The balance-beam sensor is automatically set at the new balance position after each change in conditions. It is equipped with anti-hunting and over-travel devices. It works on either liquid level or system pressure sensing and can include indicators or recorders. For full details, write for Serv-trol Bulletin.

HEALY-RUFF COMPANY

783 Hampden Avenue, St. Paul 14, Minnesota

First in dependable controls for water works and sewage—since 1929

equipment especially designed for the needs of waterworks men.

Among the items described there are: a new flexible socket valve wrench that solves the problem of getting at valves when the valve box has shifted out of plomb; split repair sleeves to make a fast, permanent repair to pipe or damaged bells; test plugs that can be used over and over again; connecting sleeves with flexible mechanical joints; hydraulic and manual pipe cutters; cast iron tapped saddles; hydrant and ratchet wrenches; hydrostatic relief valves; and pipe tongs.—James B. Clow & Sons, Inc.

Circle No. 736 on Reader Service Card

Valve Catalog

Sixteen-page catalog 10-B illustrates and describes this manufacturer's extensive line of products, including bronze, iron body and cast steel gate, globe and angle, and check valves; bar stock valves, and forged steel gate valves.

The catalog shows illustrations with condensed descriptions and specifications for each type of valve.—R-P&C Valve Div., American Chain & Cable Co., Inc.

Circle No. 737 on Reader Service Card

Pump Drives Bulletin

20-page technical brochure illustrates and describes this manufacturer's various lines of pump motors and drives. Data presented will expedite the selection of the optimum motor or drive for each specific pump application.

The brochure is indexed so that motors and drives may be identified as to construction types (solid shaft, hollow shaft, submersible, horizontal, etc.); as to enclosure (weather protected, totally-enclosed, explosion-proof, etc.); as to thrust (high, medium, normal); and as to U. S. type designation.

Condensed specification data include rating, dimensions, thrust capacities in pounds, speeds, frame sizes, ratios and selection charts (for gear drives), and electrical specification material.—U. S. Electrical Motors Inc.

Circle No. 738 on Reader Service Card

Water Storage Review

Four-page, easy to read Journal T-2 contains some interesting articles with excellent photographs on new construction of water storage tanks, tanks that have withstood unusual catastrophies, and those with extra longevity.—Steel Plate Fabricators Association.

Circle No. 739 on Reader Service Card

Water and Sewage Work Improvement

It is recognized that such severe conditions as weathering, freezing and thawing, saturation with water and chemical corrosion are among the most severe conditions confronting concrete in water and sewage works.

A 20-page brochure, Bulletin MBR-P-5, recently published by this manufacturer, describes the outstanding performance obtained under actual operating conditions through the use of Pozzolith concrete. It includes owners' reports and studies of 35 installations. Factors considered for proportioning of concrete for severe exposure to produce low permeability and high durability are also discussed.—The Master Builders Co.

Circle No. 740 on Reader Service Card

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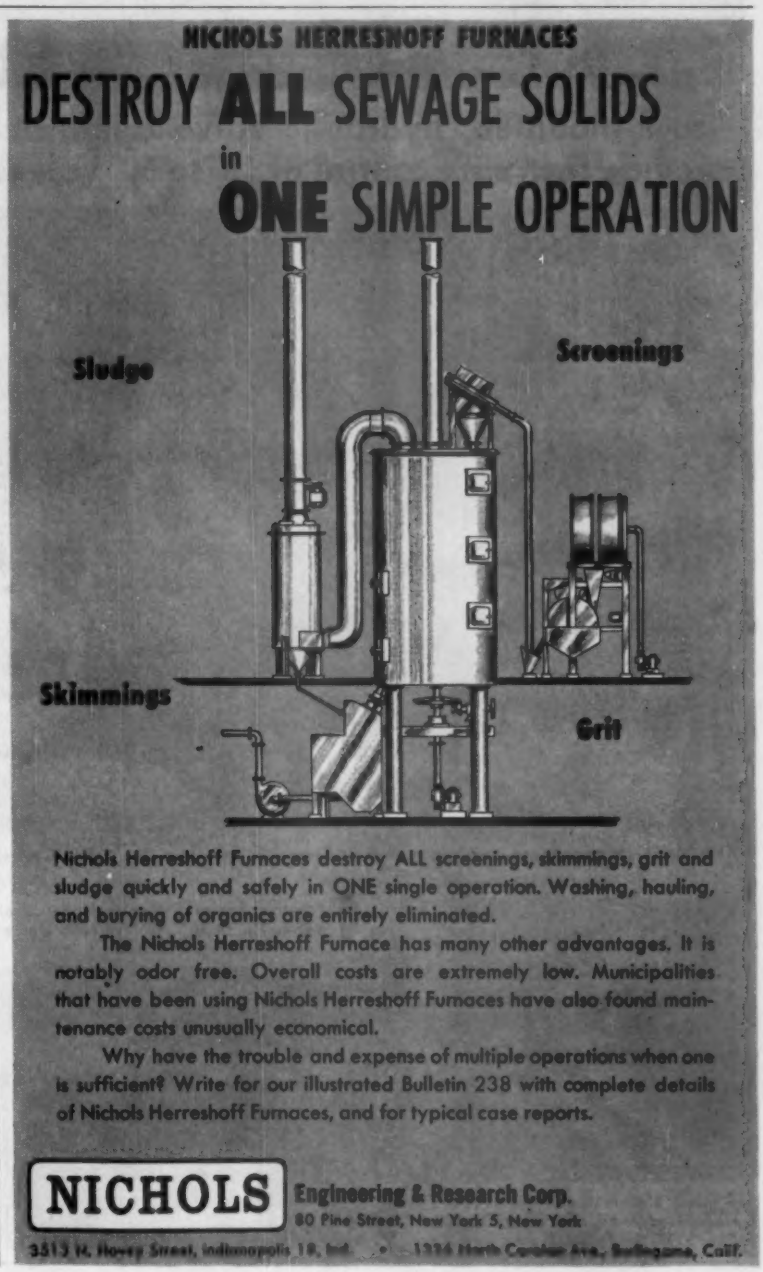
NICHOLS HERRESHOFF FURNACES
DESTROY ALL SEWAGE SOLIDS
in
ONE SIMPLE OPERATION
Sludge
Screenings
Skimmings
Grit
Nichols Herreshoff Furnaces destroy ALL screenings, skimmings, grit and sludge quickly and safely in ONE single operation. Washing, hauling, and burying of organics are entirely eliminated.
The Nichols Herreshoff Furnace has many other advantages. It is notably odor free. Overall costs are extremely low. Municipalities that have been using Nichols Herreshoff Furnaces have also found maintenance costs unusually economical.
Why have the trouble and expense of multiple operations when one is sufficient? Write for our illustrated Bulletin 238 with complete details of Nichols Herreshoff Furnaces, and for typical case reports.
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New Literature

CONTINUED FROM PAGE 101A

Ball Valve

6-page brochure gives full information on the design, construction details and principle of operation of the manufacturer's new Rubber Seat Ball Valve. It is bubble-tight at one psi to 250 psi, and has successfully eliminated all jamming or wedging problems. Standard sizes range from 10 in. through 48 in.

The new ball valve is especially suited for off-on or throttling service in pipelines, discharge from dams or reservoirs, and control systems.—Henry Pratt Co.

Circle No. 741 on Reader Service Card

Honeywell-Beckman System for pH Measurement

Specification Sheet S914-1 describes the integral Honeywell-Beckman system for pH measurement. The new model 75 Beckman pH Amplifier is mounted in any of a variety of Honeywell "ElectroniK 15" instruments, for greater ease of measurement and economy of installation. It is no longer necessary to install a separate amplifier. The electrode leads are now just run directly to the recorder. The new Model 75 amplifier uses the same standard Beckman glass and reference electrode and the same Thermo-Compensator used with the externally mounted Model W pH amplifier. Complete specifications and ordering information are included in the sheet. —Minneapolis-Honeywell Regulator Co.

Circle No. 742 on Reader Service Card

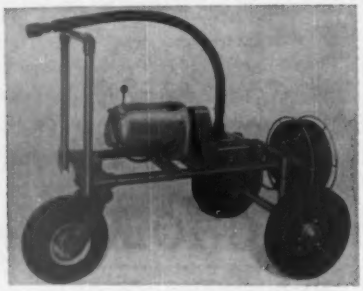
Payne Dean & Company, Clinton, Conn.

Truck-mounted, hydraulic valve operators provide fast, safe control of 10" to 60" valves

One Man Control of Speed and Torque on Gate Stem with Indication. Two Safety Control Devices.

4-Speed Electric Motor Gatenders. For Floor-Stand and Under Floor Operation. 1 to 5 HP 10" To 36" Valves.

Portable Engine Driven Gatenders, For Valves 10" to 36". All Hydraulic Operation. Two Safety Features.



Boiler Feedwater Treatment

24-page Bulletin 30 discusses in detail the importance and need of treating boiler feedwater.

The many aspects of this subject are covered under four main headings; Water, the Raw Material for Making steam; Why Water Treatment is Needed; Removing Impurities from Water; And Treating Boiler Feedwater. In addition, the bulletin offers an Appendix containing data used in water chemistry, abbreviations and symbols, and conversion factors more commonly used. —Nalco Chemical Co.

Circle No. 743 on Reader Service Card

Pneumatic Totalizer

Specification data sheet gives complete information on new Model 282-09 panel mounted Pneumatic Totalizer.

Modern in appearance and finish, it provides an accurate, trouble-free component in a pneumatic system, not only as a Totalizer, but, with the addition of an optional enclosed mercury switch, as a transmitter for operation of secondary equipment, or for start-stop pacing of chemical feeders. The unit will operate on either square root or linear signals. Hard to handle multipliers are eliminated and readings require only the addition of zeros.—B-I-F Industries.

Circle No. 744 on Reader Service Card

Carbon Dioxide Manufacturing System

Bulletin CD-260 illustrates and describes a new carbon dioxide manufacturing system.

Water works using moderate and large amounts of CO_2 can produce their own high purity CO_2 with one of these systems for a fraction of purchased cost and at the same time eliminate handling of cylinders.

These systems utilize diesel oil, fuel oil or natural gas, or can extract CO_2 from existing boiler flue gas. They are simple, packaged, easy to operate and automatically maintain a constant supply of CO_2 for peak demands. Standard packaged systems are available from 50 lbs. per hour upwards.—Louis DeMarkus Corp.

Circle No. 745 on Reader Service Card

Protective Coatings

10-page brochure describes at length this manufacturer's painting systems for the preservation of steel water tanks.

The three distinct systems described are the Nocoro® Vinyl, the Nocoro Epoxy and the Nocoro Epoxy Primer with Vinyl top coats. Each system has its merits and these are explained in the bulletin. In addition, specifications for each system are included.—Industrial Paint Co.

Circle No. 746 on Reader Service Card

Valves and Accessories

Catalog available on request illustrates and describes this manufacturer's extensive line of valves, accessories and specialties for water filtration and sewage treatment plants, as well as for water distribution systems.

Products include Flanged Gate Valves, sizes 2 in. through 42 in.; Flap Valves; Plug Drain Valves; Sluice Gates; Shear Gates; Check Valves; Square-Bottom Valves and many others.—Iowa Valve Co., Subsidiary of James B. Clow & Sons, Inc.

Circle No. 747 on Reader Service Card

Automatic Alternator

2-page Bulletin ALT-1 illustrates and describes this manufacturer's Alto-Trol, an automatic sequence changer which, when used with suitable pilot device will allow two to five pumps to be alternated one at a time at the end of each pumping cycle.

While the pumps are alternated one at a time in sequence, any time the demand calls for more than one pump to be operated, the pilot device will govern and as many pumps will operate as are required. Pump life is greatly increased, due to more even wear.—Healy-Ruff Co.

Circle No. 748 on Reader Service Card

Primary Sewage Treatment Plant

8-page Catalog 300 describes the Spirahoff®, a primary settling and sludge digestion plant in a single structure or a component of a complete plant. Catalog contains technical data, specifications and drawings.—Yeomans Brothers Co.

Circle No. 749 on Reader Service Card

Combination Pipe-Leak Locator

Brochure illustrates and describes this manufacturer's new LC-5 T "Dualtronic" which combines a Pipe Locator of great versatility with an extremely sensitive microphone and circuit for use in pinpointing water

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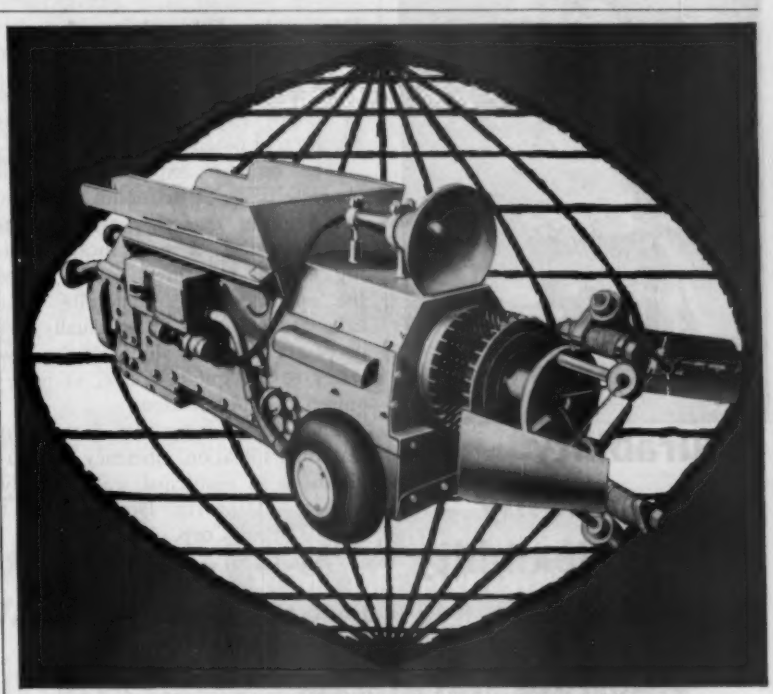

DEFENSE WEAPON
against the population explosion

CEMENT LINING BY CENTRILINE

More people coming, and that means a booming demand for water. Mains must carry new loads. The Centriline process helps assure full carrying capacity at all times.

Centriline crews, working on pipes in place, clean then line them with a smooth coat of cement mortar. The machine shown above sprays and trowels the new lining, in specified thicknesses up to ⅜", for mains as large as 24". Other Centriline machines can revive old pipe up to twelve feet in diameter.

Centrilining means no more tuberculation or corrosion, and a carrying capacity often greater than when the pipes were new. Of course, Centrilining can be accomplished at a small fraction of the cost of laying new pipe.

Send now for our illustrated brochure which explains the process and shows how Centrilining can help save lines that might otherwise have to be replaced.

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Re-new your structures with GUNITE!

★ durability
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- CONCRETE TANKS
- FILTER PLANTS
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New Literature

CONTINUED FROM PAGE 103A

leaks. Additionally, through a very simple manipulation the instrument will readily detect valves, valve caps, manhole covers, etc.

Transistors are used throughout the transmitter and receiver, as are other important electronic advancements, to increase sensitivity and reliability.—The Goldak Co., Inc.

Circle No. 750 on Reader Service Card

Diatomite Filtration of Potable Water

16-page Bulletin BW-13 discusses at length the subject of diatomite filtration of potable water.

The bulletin explains the basic characteristics of diatomite filtration, pointing out that the action is entirely physical: a mechanical straining out of unwanted solids. Since the openings in a diatomite filter cake are so small, it is usually not necessary to chemically treat the raw water to precipitate a floc, as is required in sand filtration.

The text covers cost factors in diatomite filtration, efficiency and applications in municipal water supply systems.—Dicalite Dept., Great Lakes Carbon Corp.

Circle No. 751 on Reader Service Card

Joint Compounds for Sewer Pipe

Two single page description sheets list data and specifications of cold applied Carey Sewertite Asphalt Base and Tar Base Joint Compound for sewer pipe, culvert and septic tank joint of concrete, vitrified clay and tile.

Information includes: product description uses, features, performance data regarding non-volatile matter, inorganic filler, chemical resistance, workability, condition in container and application. Easy-to-read tabular guide lists coverage for tongue and groove pipes from 4 in. to 36 in.—The Philip Carey Mfg. Co.

Circle No. 752 on Reader Service Card

Centrifugal Pumps

4-page Bulletin 3913 illustrates and describes this manufacturer's new, low-cost centrifugal pump line. It includes descriptions, photographs, performance tables and dimension prints for sizes 1 in. through 3 in.

The new end suction centrifugal pump employs double ball bearings and is equally suited for belt or direct motor drive. Capacity range is from 10 gpm to 300 gpm, and heads range to 150 ft.—The Deming Co.

Circle No. 753 on Reader Service Card

Small Sewage Treatment Plants

Bulletin No. 6692, an 8-page brochure, illustrates and describes the latest development in low-cost sewage treatment plants for communities up to 10,000.

The bulletin discusses the progress made since 1929 after the introduction of this manufacturer's Clarigester, a combination unit in which mechanical clarification and mechanical sludge digestion are accomplished in a single, two-story tank. Today, the development of a Degritter Clarigester provides positive mechanical grit removal in the same tank with a conventional clarifier. This new "Degritting" device removes troublesome grit from the raw sewage without the need for costly separate grit handling facilities.

This bulletin covers in detail the Degritting Clarigester, Clarigester and also includes brief descriptions of the CompleTreator and Duo-Clarigester.—Dorr-Oliver Corp.

Circle No. 754 on Reader Service Card

End-Suction Centrifugal Pumps

Four page Bulletin 117 PKG illustrates and describes this manufacturer's new "Packaged Line" of Type GP Close-Coupled End-Suction Centrifugal Pumps.

These pumps are designed for minimized effort in maintenance and inspection with complete disassembly without disturbing the suction or discharge piping. Vertical centerline discharge makes these pumps self-venting to eliminate vapor locks and provide smooth running operation. Packaged in a variety of sizes for stock delivery, these pumps range in capacities up to 400 gpm and heads up to 150 ft.—Aurora Pump Div., The New York Air Brake Co.

Circle No. 755 on Reader Service Card

Circular Collectors

20-page Bulletin No. 9-W-65 illustrates and describes this manufacturer's line of Circular Collectors especially designed for municipal or industrial water and sewage treatment, and certain industrial processes.

Bulletin explains the reasons for the selection of circular or square setting tanks rather than rectangular tanks, and describes in detail various types of units available: center pier-supported, bridge supported, and tractor drive collectors.— Walker Process Equipment, Inc.

Circle No. 756 on Reader Service Card

Hydraulic Pipe Pushers

4-page Bulletin E-232 illustrates and describes this manufacturer's line of hydraulic pipe pushers that make possible the installation of pipe underground without the time and expense of digging long trenches, breaking through concrete, backfilling, tamping and resurfacing.

With these pipe pushers, the only digging required is a short trench to accommodate the base, the pusher and the section of pipe. There are two models available: No. 790 which develops 20 tons of pushing force, and No. 795, which develops 75 tons. When a job calls for more power, two pushers can be teamed. —Greenlee Tool Co.

Circle No. 757 on Reader Service Card

Takeups

16-page Book 2741 illustrates and describes this manufacturer's complete line of takeups, in seven frame styles and equipped with sleeve, ball or roller bearings.

The book lists more than 320 different takeup units, designed to provide easy, positive means for adjusting head or foot shafts on conveyors or elevators. Complete information for selection and application with dimensional data for each frame is given.—Link-Belt Co.

Circle No. 758 on Reader Service Card

Reactor-Clarifier

The many types and applications of this manufacturer's Reactor-Clarifier treatment units for water and waste clarification are described in Bulletin SM-1006-R, a 24-page brochure.

The bulletin covers the eight types of Reactor-Clarifier units manufactured in terms of the specific treatment application for which each type has been designed. Complete specifications are included. In addition, bulletin contains a series of drawings showing flow patterns through the reaction and clarification compartments, by means of which coagulation, flocculation, recirculation and clarification are achieved.—The Eimco Corp.

Circle No. 759 on Reader Service Card

Sewage and Waste Treatment Equipment

8-page Bulletin No. 315-11 illustrates and describes this manufacturer's extensive line of sewage and waste treatment equipment for industry and municipalities.

The bulletin covers bar screens, traveling water screens, triturators, grit and sludge collectors, settling tanks, skimmers, flocculators and flotation separators.—Chain Belt Co.

Circle No. 760 on Reader Service Card

Sewage Disposal Screens

Brochure illustrates and describes this manufacturer's line of sewage disposal screens designed to alleviate many problems encountered with

CONTINUED ON PAGE 106A

SPEED SENSITIVE SWITCHES

With 1, 2, 3, 4, 5 or 6 adjustable switches in the same size container illustrated.

Any drive mountings listed which would best fit the installation can be used with any of our speed switches. The GS model will accommodate a coupling, gear or a pulley for other means of driving.

Normal speed can be as high as 7000 RPM. Low speed setting can be as low as 200 RPM if the top speed is below 2500 RPM. A governor that will make contact at 20 RPM is available.

A variety of caps and terminals are available. Request Bulletin 604.

•

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8151 N. RIDGEWAY AVE.
SKOKIE, ILLINOIS

Don't throw maintenance money away!

NoDrip TAPE PERMANENTLY PROTECTS AGAINST CONDENSATION AND RUST AT LOWEST COST.

Any maintenance man can check this. Handy 16' rolls of ¼" thick NODRIP TAPE fits any size pipe or fitting. Never absorbs moisture. *Permanently* insulates against damaging pipe sweating—even around unions, tees, angles and valves.

NoDrip PLASTIC COATING

Another fine Mortell product. Use on metals, concrete, brick, tile, plaster surfaces. Apply by brush, trowel or spray to large pipes, tanks, walls, ceilings, air ducts, to eliminate sweating. 1 or 5 gal. cans or 55 gal. drums.

At all leading hardware, mill supply and plumbing jobbers. For full information and technical handbook, write

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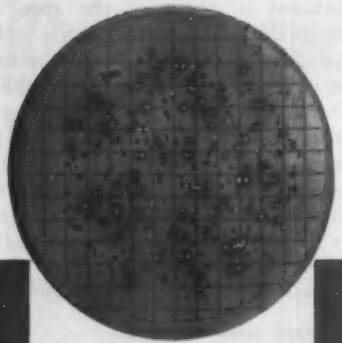

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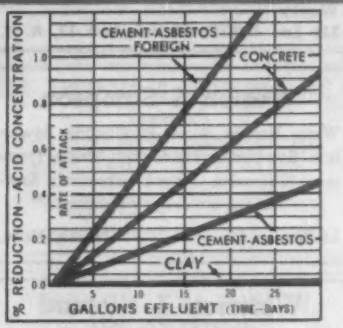

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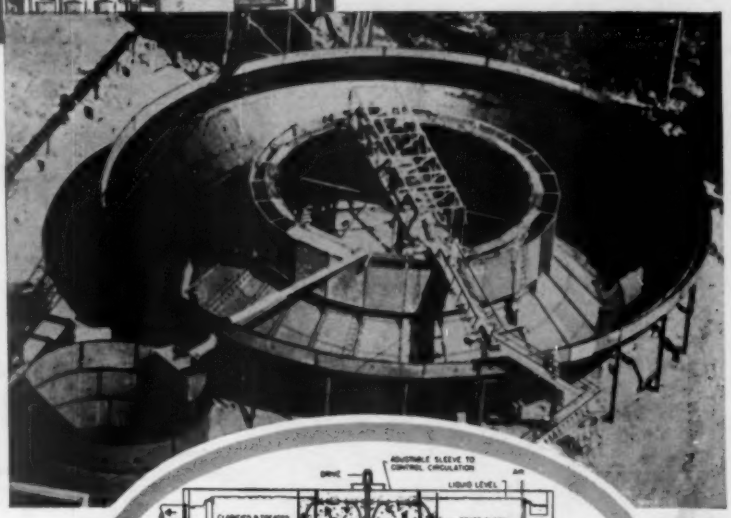
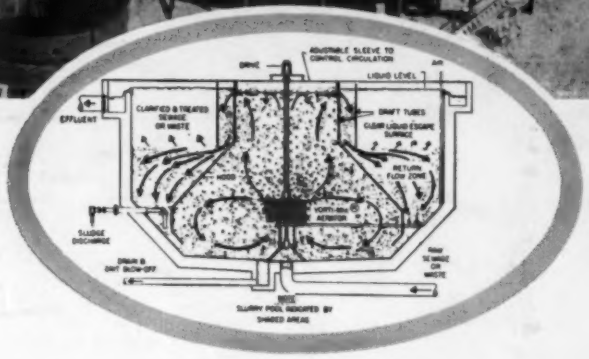


AERO-ACCELATOR®

Activated Sludge Plant for Sewage and Industrial Waste Treatment...



– 90% AND HIGHER B.O.D. REMOVALS!

– SPACE SAVINGS UP TO 50%!

– LOWEST INSTALLED COST!

The "AERO-ACCELATOR" plant offers a practical solution for complete treatment of organic industrial waste waters.

Using the most modern biological and hydraulic principles, "AERO-ACCELATOR" completely-mixed activated sludge plants carry on clarification together with biological oxidation of organic materials. They offer the additional advantages of efficient operation at high loadings, and stability under shock loads.

Bulletin 6510 will be sent on request.

Inquiries are invited on all water and waste treatment problems of municipalities, institutions and general industry.

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THE ONLY COMPANY impartially offering equipment for ALL types of water and waste processing—coagulation, precipitation, sedimentation, filtration, ion exchange, flotation, and biological treatment.